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Meteoritic Origin of the "Carolina Bays" Questioned

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The "Carolina Bays"

To acquaint the reader with the "Carolina Bays" it may be stated that these unique features consist of *several hundred thousand* shallow, elliptical depressions extending from southern Virginia into Georgia, and from the Atlantic to the base of the Piedmont. The Bays measure from a few yards to several miles in length and are elliptical to a varying degree. Their chief peculiarity is that their long axes follow approximately the same NW-SE direction. Most of them are rimmed, especially around their NE quadrant, by a collar of pure white sand. They vary in degree of perfection and ellipticity, yet their similarity is striking. It is evident that they were all formed by the same cause, but not at the same time. A glance at the Figures is more instructive than further detailed description. In the Carolina Plain, "bays" is the vernacular designation of a swampy place.

Popular Conceptions

An interesting article by Herbert Ravenal Sass appeared in a popular magazine of wide circulation, later abstracted in another equally famous magazine, to the effect that solid pieces from the head of a comet excavated the "Carolina Bays." This story, so graphically told, has seized upon the imagination of the public. Some scientists who have not analyzed the problem have been led into acquiescence of this fantastic theory. More than fifty articles and one book have been written upon the origin of the Bays.

Following is a list of some of the objections to the meteoritic theories which have been published.

No fragments of meteorites have been recovered in the entire Bay area, although the adjacent area west of the Appalachians has produced a large number of meteorites. No fused sand or broken bedrock such as is found in the Arizona Crater is associated with the ellipses. No bulging has been noted in the surrounding plain. Spoil thrown from the craters should be equal on both sides of the ellipses, but is greater along the NE quadrant. Meteorites of a size sufficient to excavate the ellipses should strike with sufficient force to explode and hence excavate circular craters. There are no known elliptical meteoritic craters on moon or earth. The long axes of the ellipses should be parallel,

but actually vary to a considerable extent—up to 52 degrees. Small Bays should be more nearly circular than larger ones, because gravity and air cushioning would cause a more nearly vertical fall by small bodies, but actually the small Bays are frequently more elliptical than many large ones. Solid bodies should have struck in zones according to their mass, but these Bays occur intermingled regardless of size. Multiple or concentric sand rims are supposed to represent several hits in the same crater, but the frequency of their occurrence and the fact that as many as six concentric rims are occasionally found makes the hypothesis untenable. The sand forming the rims is pure white, differing from the discolored sand and soil of adjacent plain or ancient beach ridges and is not what should be expected if thrown from a crater. A projectile plows a furrow wider than itself, but the Bays are so wide as to necessitate enormous projectiles such as would have burst the bedrock and exploded circular craters. No rim contains over 1/25 of the volume of the crater. Where rims intersect there should be more spoil, but this is not the case. The volume of the rim is unrelated to the size of the Bay. Rims are too low, wide, and asymmetrical to represent spoil.

Scientists have searched for a suitable explanation of the origin of the Bays, attempting to find the answer among the three groups of forces which alone can modify the surface of the earth, namely, geophysical, meteoritic, and biological.

The greatest group of forces is the geophysical, which includes wind, water, erosion, glaciation, volcanism, shifting, faulting, warping, tides, currents, waves, and so on—inanimate terrestrial forces. The second, or meteoritic force, has to do with bombardment from space. We can see the enormous changes wrought upon the face of the moon by meteorites, and realize that the earth must have received its proportionate share, but our perspective is so short that we do not realize the vast effect that bombardment has had upon our own planet. The third and last group of forces is biological. Our coal measures, chalk cliffs, coral reefs, and oil deposits are recognized as having had a biological origin. Lesser changes have been wrought, such as game trails, buffalo wallows, termite nests, beaver dams, angle worm holes—animate forces.

Bombardment by meteorites was once assigned as the cause of the Bays, but gradually this theory has lost ground. The geophysicists sought many explanations, but in turn lost interest in a problem which they have as yet been unable to solve. The latest turn has been for each to pass the problem to the other. As an example, Dr. F. C. Leonard, a noted meteoriticist, believing that the origin of the Bays did not come within his sphere, stated that they "belonged to the sphere of geomorphology."[1] Thus, he definitely assigned a sphere without considering a biological origin as a possibility. The present writer believes that the Bays had a biological origin.[2]

[1] Popular Astronomy, May, 1947, p. 276.
[2] *Scientific Monthly*, **61**, 1945, pp. 443-450. See also conclusion to this paper.

Craters

It is necessary to consider all known meteoritic craters in order to be able to differentiate them from the "Carolina Bays." Our best example is the moon. Study of photographs of the moon such as H-17 which appeared in Mr. Allen O. Kelly's article, "The Geology of the

Figure 1
Photograph H-17
(Made at Mount Wilson Observatory)

Moon,"[3] will show that the moon is heavily pocked by relatively shallow

[3] Popular Astronomy, December, 1947.

craters of all sizes and that they are all circular. Allowance must be made, of course, for the seeming ellipticity of craters towards the edges of the photographs which are viewed at an angle due to the spherical surface of the moon and due to the fact that no photograph showing any considerable surface of the moon can be viewed vertically in its entirety by the eye of a camera. Unfortunately the public has been misinformed to the effect that the moon is pocked by "bubbles" and "volcanic craters." Some of these "bubbles" are hundreds of miles across. The smallest ones visible in the photograph are perhaps three miles in diameter.

A bubble is a more or less spherical body of gas which rises to the surface of a liquid medium. Upon emerging, it is covered by an elastic, cohesive dome which usually bursts and is blown outward or collapses. The components of the earth or of the moon could not possibly form a hollow dome of any great diameter. The largest bubbles or blisters known on earth are found in lava and are a yard or two in diameter. There is no reason to believe that lunar bubbles would differ greatly from terrestrial ones. Inspection of the lunar craters makes it evident that they were not formed in one epoch, but have been accumulating for ages, since small craters are found within larger ones. Hence the moon could not have been "molten" during the formation of *all* craters. Gas escaping through a solid would tend to seek vents or tear jagged holes and escape with a "swish," not by explosion of a large circular area.

As to the craters on the moon being of "volcanic" origin, it is only necessary to compare them to the known volcanic craters of the earth which are associated with steep cones. No such isolated cones are seen on the moon, which is subject to the same physical forces as the earth is. Possibly their absence may be associated with the absence of water on the moon. There is no similarity between lunar craters and terrestial volcanic ones. Lastly, the claim of the exponents of "bubbles" and "volcanism" was always modified by "some." They all agreed that a part of the lunar craters were of meteoritic origin. The writer believes that all the lunar craters and "seas" were caused by a single agency.

There are only a few craters on the earth which scientists admit to be of meteoritic origin. The best example is the Arizona Crater which is roughly circular. There seems to be no valid reason to doubt that the earth received proportionately as great a number of hits as did our satellite. But, where are they? Weathering on the moon is limited to fracture due to expansion and contraction from the great thermal difference between sunlight and darkness. This difference amounts to about 600 degrees F. On the other hand, the craters on the earth have been largely destroyed by erosion, deposition, chemical action, and, to a greater extent, by tidal waves induced by the striking of large meteorites in the sea *or* on land. If one studies the shape of the mountain

ranges, being careful to eliminate all deposited or transported material, such as valley floors, the resultant basic structure is seen to follow curves reminiscent of parts of lunar craters and jumbles of overlapping craters.

The cortex of the earth, being lighter than the core, would, upon cooling, crack open due to greater shrinking. Thus, the old simile of the mountains being like the skin of a shriveled apple is based upon a fallacy. The skin of an apple does not dehydrate proportionately to the pith, and hence is too large for its shriveling center, and as a consequence becomes ridged. No similar action should be ascribed to the earth. The most logical assumption being that all inequalities on the surface of the earth are due directly or indirectly to meteoritic impact and that the present rising, falling, and faulting are due to readjustments caused by gravity, either upon ancient crater rims, accumulations of eroded material, or accumulation of ice at the poles during glacial epochs. Thus, excluding the Carolina Bays, all known meteoritic craters are circular or very nearly so—definitely *not* elliptical.

Theories of the Meteoriticists

Most astronomers and meteoriticists disclaim that the Bays belong to their field of study, but there are several stout defenders of the meteoritic school. Among them, Dr. W. F. Prouty, of the University of North Carolina, and Mr. H. H. Nininger, Director of the American Meteorite Museum, are probably the most zealous. This paper attempts to marshal the arguments pro and con and to add some new ones in an attempt to sound the requiem of the meteoritic hypothesis. Another paper is in preparation which will attempt to treat the geophysical theories in like manner.

Meteorites cannot select their landing places, yet it can be demonstrated that the Bays do not occur in a hit or miss manner, but are definitely correlated with several features of the terrain, such as beach ridges, the drainage system, and elevation. Added to this, meteorites cannot account for specific Bays. As a consequence, it would seem that a meteoritic hypothesis would be laid permanently to rest.

Two schools of thought exist among the meteoriticists concerning the Bays.

(1) Large meteorites are supposed to have ploughed out the Bays to their present dimensions, leaving the spoil in the form of the present rims.

(2) Smaller meteorites are supposed to have driven compressed air downward with sufficient force to blow the loose top soil away, leaving shallow depressions around which the soil fell back to form the present rims.

The two schools agree that all the Bays must have been formed at one time by a single swarm of meteorites.

The Theory of Large Meteorites

Before launching into this theory of total excavation by large meteorites, it is well to glance at a few statistics presented by Dr. C. C. Wylie.[4] Dr. Wylie says that the weight of atmosphere displaced by a vertically falling iron meteorite is approximately three times the square of its radius in feet. (A stone meteorite weighing half as much per volume—the weight of air is doubled). Examples: An iron six inches in diameter, weighing 30 pounds displaces six times its weight of air, and hence its fall is greatly slowed down or cushioned. One two feet in diameter, weighing one ton, displaces three times its weight and is of sufficient size to form a "ball of fire" persisting to a strike. A six foot, 27 ton iron displaces its own weight. One 100 feet in diameter weighs 100,000 tons, or 17 times as much as the air displaced. Its original velocity is only slightly checked and it would suffice to produce an "Arizona Crater." In a strike, the kinetic energy liberated increases as the square of the velocity. A rifle bullet traveling at one-half mile per second melts when it strikes a hard target. A meteorite striking at 2.3 mps has the explosive effect of its own weight of nitroglycerine; at 10 mps it equals 19 times its weight of nitroglycerine; 25 mps, 120 times; 40 mps, 306 times.

This shows the impossibility of large meteorites causing other than an explosive force which would excavate circular craters. It is physically impossible for a large projectile to be sufficiently slowed by the atmosphere to cause a plowing effect which might produce a figure approaching an ellipse, provided the projectile ricocheted off into space. If it did not ricochet, the crater would not be a perfect ellipse, and, if it did ricochet, it would possess sufficient force to cause an explosive or round crater. No claim has ever been advanced that a meteorite could ricochet.

Melton and Schreiver[5] are considered to be the originators of the meteoritic origin of the Bays, but Mr. Edwin Howard Corlett[6] claims to have suggested the theory to them.

Some might claim that in spite of Dr. Wylie's figures, large meteorites may have struck at such a low angle that the distance of air traversed might have been sufficient to cause a cushioning and thus reduce their speed sufficiently to cause a plowing effect instead of an explosive force. Therefore, let us examine two cases which the meteoriticists prefer to evade, namely, 1. Small ellipses within a larger one; 2. Overlapping ellipses.

Examples exist of large Bays partially surrounded by their sand rims, within which exist smaller Bays with sand rims at the same level as that of the "parent." If the smaller Bays were plowed from the bot-

[4] On the formation of meteoric (sic) craters, Popular Astronomy, **41**, pp. 211-214, 1933.

[5] *Jour. Geol.*, **41**, 52-66, 1933.

[6] *Scientific Monthly*, **64**, 187, February, 1947.

tom of the "parent," how could their rims come to the same level as that of the parent? We will not press the fact that the Bays are filled with peat, but meteoriticists are in agreement that all the Bays were excavated at one time and within a matter of seconds. (See Figure 2. a,

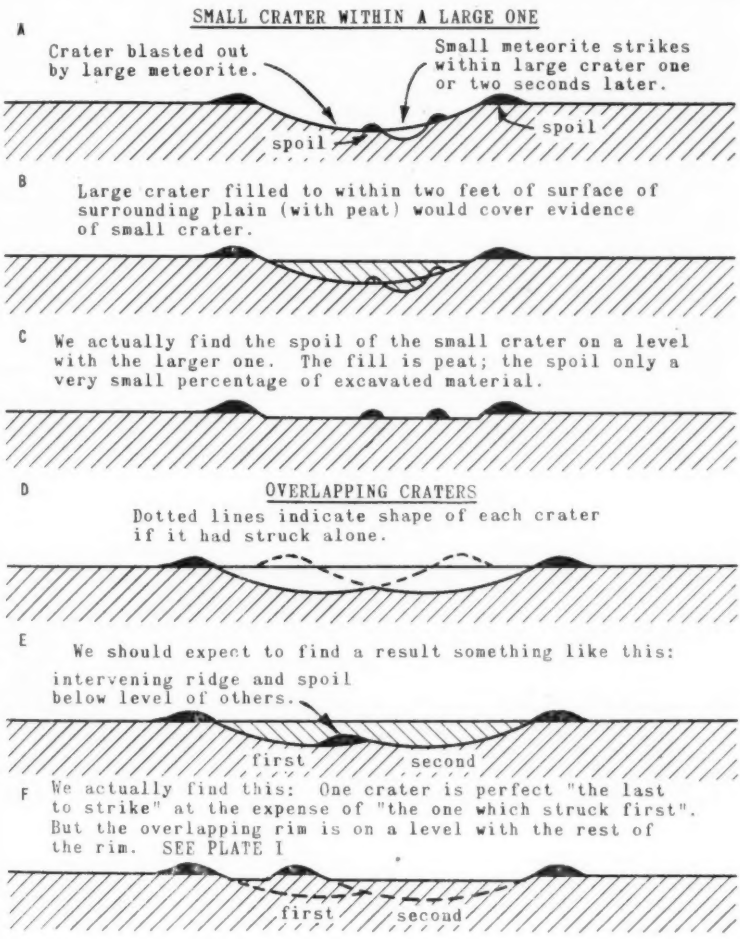
A
SMALL CRATER WITHIN A LARGE ONE
Crater blasted out by large meteorite.
Small meteorite strikes within large crater one or two seconds later.
spoil
spoil
B
Large crater filled to within two feet of surface of surrounding plain (with peat) would cover evidence of small crater.
C
We actually find the spoil of the small crater on a level with the larger one. The fill is peat; the spoil only a very small percentage of excavated material.
D
OVERLAPPING CRATERS
Dotted lines indicate shape of each crater if it had struck alone.
E
We should expect to find a result something like this:
intervening ridge and spoil below level of others.
first
second
F
We actually find this: One crater is perfect "the last to strike" at the expense of "the one which struck first". But the overlapping rim is on a level with the rest of the rim. SEE PLATE I
first
second

FIGURE 2

Diagram showing the inadequacy of a meteoritic hypothesis in explaining contained craterlets or overlapping craters.

b, c. See also Figure 3 center bottom and Figure 6 top center and lower left corner.)

FIGURE 3

← — — — — 3½ miles — — — — →

Note the perfect ellipse at upper right across which curved water channels can be seen. The direction of the ancient current and the fact that these marks are curved preclude their being considered as any part of ancient beach ridges. The white sand was obviously water-carried by the northeasterly flowing current. The fact that a thin rim of sand was deposited along the SW rim shows that some active agent piled some sand *against* the current.

At bottom center there are 3 bays in a chain. Note that the center one overlaps the lower one (of which only a half appears on the plate) but that the *entire* interlocking rims of *each* is visible. This single case disproves a meteoritic origin of the Bays.

Examples of overlapping Bays are frequent. Occasionally a pair is found wherein the "newer" or overlapping Bay shows a perfect sand rim to the same level as the "older" or overlapped Bay. The problem here is a modification of the first. How could a rim, blasted from the side of one Bay protrude to the same level as that of the older Bay? (See Figure 2, d, e, f.)

Another inexplicable example of overlapping is seen in Figure 3, center bottom. Here two overlapping craters show complete ellipses. If one hit first and formed a complete ellipse, well and good, but how could a second overlapping one blast its basin and not obliterate the overlapped part of the first? If they hit at the same instant, *neither* overlapped segment would remain.

Dr. Murray F. Buell[7] made traverses of Jerome Bog with a peat augur. This Bay is about 6200 feet long by 4250 wide. The deepest accumulation of peat is a small, eleven-foot deep area near the center. The greater part is five to eight feet deep, sloping gradually to the rim. Dr. Buell's section is drawn with exaggerated vertical component and appears somewhat like our Diagrams in Figure 2. However, if we redraw his sections to true scale, we find a startling figure. Using a scale of 1/100 inch equals one foot, we find that the greatest depth is abut 1/10 inch, but the *length* of the diagram would be about 63 inches! Even the most enthusiastic meteoriticist would hesitate to consider this almost flat figure as representing the work of a large, gouging meteorite, especially if compared to the Arizona Crater! A true scale diagram cannot conveniently be represented on one page!

The Theory of Small Meteorites and Air Blast

Dr. William F. Prouty[8] saw the impossibility of huge meteorites gouging out the "Carolina Bays," so he evolved a theory wherein he claimed that small meteorites forced sufficient compressed air before them to blow away the loose top soil and sand which then settled to form the ellipses we see today. The missiles penetrated into the ground for a distance of a mile or two, curving southward due to the rotation of the earth, where they may now be detected by the magnetometer.

This theory presupposes that hundreds of thousands of missiles struck the earth within a few seconds and blew the loose top soil into the air, whence it descended in the form of ellipses. (See Figure 4 for a conception of the vast number of Bays.) These ellipses form over 50% of the land surfaces in some areas, making it difficult to visualize such a maelstrom of agitated sand and dust resolving itself into ellipses of slightly varying proportions and axes; each rim of pure white, care-

[7] Jerome Bog, a peat filled "Carolina Bay," *Bull. Torrey Botanical Club*, **73**, pp. 24-33, Jan., 1946.

[8] *Jour. Geol.*, **43**, pp. 200-207, 1935. See also *The Compass of Sigma Gamma Epsilon*, pp. 235-244, May, 1943. The same basic theory was advanced by Dr. Gerald R. MacCarthy, *Bull. Geol. Soc. Am.*, pp. 1211-1226, September, 1937.

FIGURE 4

← — — — — 9¼ miles — — — — →

Note that no streams run *into* a Bay. The Bays are situated *between* and *away* from the drainage arteries. Note the enormous number of Bays of all sizes, covering over 50% of the surface. The light areas are cultivated land. Years of plowing does not obliterate a Bay.

fully sorted sand, free from coarse material or the brown earth which exists in all directions.

If we can overlook this first objection, Dr. Prouty's theory over-

comes some of the objections to the "gouging" of the large-meteorite school of thought. However, any meteorite that could penetrate soil for a distance of two miles, one mile, or even a quarter of a mile would have to be traveling at such speed that an explosion would occur, making a circular crater with scarcely any penetration.

The Bays toward the south of the area point more nearly north and are ovoid, with the small end southward. Dr. Prouty's explanation for this is that the descending meteorites formed a "gas" which forced the southern part of the swarm more southward. He gives no explanation to account for the fact that the northern ellipses were not forced to a more nearly east-west axial line by this central, expanding column of gas. We are not told how a gas could be generated within two seconds which would exert sufficient force to deflect solid bodies of assorted sizes in approximately equal degree — bodies falling with sufficient force to penetrate the earth for two miles!

The ovoid shape of the majority of the southern Bays cannot be attributed to any component of the earth's movement, because both ovoid and elliptical craters are found intermingled to some extent. Dr. Prouty states that the rotation of the earth caused the meteorite to arc southward in its supposed two-mile penetration of the soil. He omits mention of the fact that at this latitude the earth rotates at only about seven-tenths mps, whereas, it is progressing on its orbit at 18 mps. Thus the component of rotation would be negligible. The orbital movement would account for over 18 times as much as the rotation. There is also a doubt that motion of the earth would deflect a penetrating body, and lastly the magnetometer tests are far from being convincing that buried meteorites do exist under the plain. The fact that the solar system is moving at 12.2 mps towards Hercules does not change this picture, since meteorites are moving with the solar system.

Dr. Prouty wished to prove his hypothesis, so he shot a rifle bullet at a low angle into a plastic medium which was covered by a layer of light dust. He says that the bullet made a small hole in the plastic and blew the dust into an ellipse. Photographs of this experiment are lacking and no assurance is given that the muzzle-blast was eliminated. This could have been neutralized by firing through a cloth or paper hung between the muzzle and the target. He did not experiment with multiple missiles, such as would be made by a shotgun. Such an experiment should be expected to throw light upon the formation of the crowded and overlapping ellipses of the Bay region.

The fact that the air compressed by a bullet fired at an angle might blow loose dust away from the small pit which it makes in a plastic medium is no reason to believe that sand could be blown several miles and settle in any coordinated pattern, especially in cases where ellipses overlap and *both* rims are visible in their entirety (Figure 3, bottom center).

As in the "large-meteorite" hypothesis, it is impossible to account

for small Bays within large ones, or overlapping rims by this air-blast theory. I attempted to repeat Dr. Prouty's experiment but attained a different result. The bullet made a hole in the plastic many times its size with highly elevated, rough edges, but the dust overlying the plastic was not blown into an ellipse, but was merely roughened for a small area surrounding the hole.

Speed of Strike and Shape of Swarm

Inasmuch as formations similar to the "Carolina Bays" are unknown elsewhere, scientists agree that if they were formed by meteorites, they were formed at one time by one swarm, coming from one direction. The long axes of the Bays being NW-SE, the swarm must have struck from the NW *or* the SE. To date, no one has advanced an hypothesis considering a southeasterly attack, probably because of the fanning-out of the southernmost Bays to a more southerly direction. Therefore, if we consider one swarm hitting at one time from the NW, at a fairly low angle, we can arrive at an inkling of the speed of the missiles; the time between the first and last strike and the shape of that part of the swarm which made the Bays.

Let us consider two meteorites approaching the earth from the northwest, over *identical paths* to the Carolina Plain, and let us omit terrestrial atmosphere in this consideration. These two meteorites are at such distance apart as to strike the earth at an interval of *one* second. If the solar system were motionless in space, the two meteorites would strike at the same identical spot one second apart. If only the rotation of the earth is considered, which is about 7/10 mps at the latitude of the "Carolina Bays," the second meteorite would strike 7/10 miles west of the first. If the 18 mps orbital motion of the earth is added, the second would strike 18 7/10 miles west of the first.

At what distance apart were these two meteorites in order to strike the earth at an interval of one second? The following facts apply only to meteorites approaching from a westerly direction. If an easterly direction is considered, the opposite of these statements would apply. If they struck at night, which would necessitate its being a following blow, their speed would have been the vector of 26 mps[9] minus 18, or a remainder of 8 mps. In this case we must have had to select two meteorites traveling only 8 miles apart (See Figure 5). If they struck in the daytime, their speed would have been the vector of 26 plus 18, since it would have been a meeting blow, or 44 mps and therefore the missiles were 44 miles apart. The width of the zone of Bays is about 40 miles from the Atlantic to the Piedmont. This segment of the earth would pass a point in space in a little more than two seconds.

We can now reconstruct the shape of the part of the swarm which is supposed to have made the Bays. It would have had to be in the

[9] 26 mps is the usually accepted figure for the speed of all meteorites, regardless of size, traveling through space.

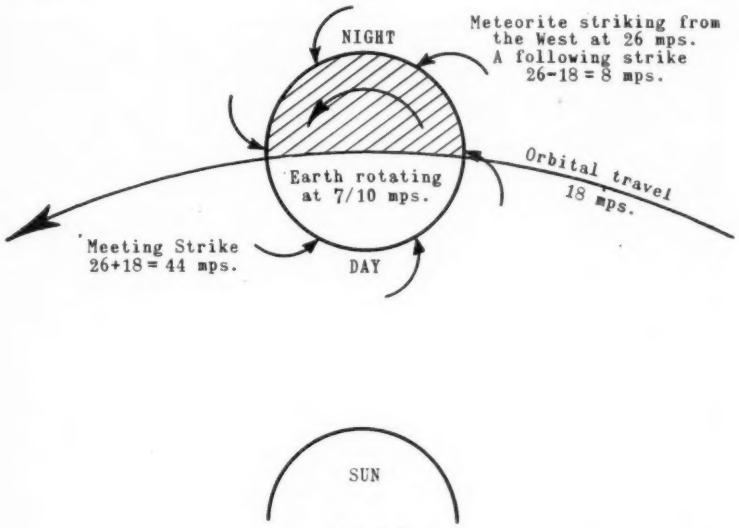
NIGHT
Meteorite striking from the West at 26 mps.
A following strike 26-18 = 8 mps.
Earth rotating at 7/10 mps.
Orbital travel 18 mps.
Meeting Strike 26+18 = 44 mps.
DAY
SUN

FIGURE 5

Diagram to show the difference in striking velocity between two similar meteorites striking during the day or during the night.

form of a disc, hitting edge-on—a disc 400 miles wide, but cut to a *depth* of only 16 to 88 miles—just a slice of a disc. To be 16 to 88 miles deep, it must have been only *one* meteorite thick, or if thicker, it must needs have had less depth. It is diffcult to reconcile these facts with any assumed shape or density of a swarm of meteorites. The shape of the Bay area does not suggest a segment of a circle or ellipse.[10]

SITES OF THE BAYS WERE SELECTED

Meteorites cannot select their place of strike, but by studying the maps, it is evident that the Bays occur in locations limited by certain definite factors. They are not distributed promiscuously. We find that the Bays have these limitations.

1. Correlation with ancient beach ridges (Figure 6).
2. Correlation with drainage system (Figure 4).
3. Limitation of altitude.
4. Confined to flat areas.

1. The ancient beach ridges that stand out so clearly in an airplane

[10] The head of a comet is probably nearly spherical and the solid missiles within it are generally conceded to be considerably separated from one another. The missiles in a "swarm" of meteorites are generally conceded to be much farther apart than in a comet, yet the Bays cover over 50% of the land area in certain localities, with their centers frequently a fraction of a mile apart—a concentration more dense than any conception of a comet's head.

FIGURE 6

← — — — — 10 miles — — — — →

The light colored lines running NE-SW are ancient beach ridges. The darker lines are drainage. The beach ridges are only 18 inches high, but determine the location of the Bays which are *aligned* between them. No physical force can control meteorites to force them to strike in lines.

mosaic photograph are in reality very low. They average about 18 inches high and about 300 yards across. In traversing them, their position is more clearly noted by the change of the vegetation than by the slight slope. Their formation can be explained by their having been

built in shallow water in the presence of an off-shore wind. The height of a wave cannot equal the depth of the water where it is formed. An off-shore wind would tend to keep the beaches low by blowing exposed sand back into the water where it would be re-distributed by the waves and current. The present line of coastal sand dunes built in the presence of an on-shore wind is from 20 to 40 feet high. An on-shore wind piles sand above the reach of waves, whence the wind piles it into dunes.

There is no instance of the Bays interrupting the ridges since the Bays lie between them. This is one proof that the Bays were formed under water, as the ridges were very evidently formed at water level. Thus we find a direct correlation between the Bays and beach ridges (See Figure 6).

It has been stated that an airplane picture shows the pattern of beach ridges across a Bay. This would refute a meteoritic hypothesis of course, but the important point is that the pattern seen crossing a Bay was made by a water current flowing northeasterly. This current was doubtless a part of or a predecessor of the Gulf Stream (Figure 3, upper right).

2. Rivers do not empty *into* the Bays. The Bays are located *away* from the main drainage system. In no case are fragments of Bays found upon two sides of a main drainage artery, although many Bays are so large that they could lie across the widest stream beds of the area and still leave evidence of their presence. Here we see a direct correlation between the Bays and the drainage system (Figure 4).

3. Bays do not exist above a fixed altitude. The highest of which I am aware are about 250 feet above sea level. There are large areas just above this altitude that are to all appearances exactly like territory that includes the Bays, but these higher levels are without a trace of Bays. The 250 foot contour does not curve as a periphery that a swarm of meteorites might be expected to follow, but is deeply convoluted. This maximum elevation is close to estimates of change of sea-level during glacial-interglacial periods. A direct correlation is thus seen between the Bays and elevation.

4. Bays are confined to flat areas and swales between hillocks. Aeroplane mosaics are deceptive in that they give the appearance of a generally flat, level area, known as the "Carolina Plain." Actually this area is rolling for the most part. Bays do not occur on hillsides or hit and miss as has been stated by Dr. Prouty.

Conclusions

I have endeavored to add to the evidence that the "Carolina Bays" could not have been formed by meteorites. First: In the aggregate, by pointing out that the Bays are elliptical, which is at variance with all lunar and earthly meteoritic craters; that the form of the area is not consonant with any "swarm" or comet's head; that the "strikes" are

too close together to conform to any conceivable aggregation of meteorites; that the Carolina Plain does not possess any characteristics peculiar to itself and that elliptical craters are found nowhere else on earth or moon; that the moon, being without water, has retained the forms of innumerable meteoritic impacts and that the earth has received proportionately as great a number, but that the presence of water has defaced them to such an extent that man cannot recognize them as such because of his worm's-eye-view; that the locations of the Bays are very evidently *selected* to conform either to elevation, and to low, ephemeral, ancient beach ridges, and to eschew drainage arteries, and to require flat surfaces; that in cross section they are found to be so flat as to preclude the possibility of their having been gouged out. Upon analysis of individual Bays, I have pointed out the impossibility of small Bays within a large one having rims of the same height as the "parent" Bay; that if gouged, it would be impossible for two interlocking Bays to have retained their rims entire, as is shown to be the case in the Figures. I have shown that the arrangement of the Bays is entirely at variance with any logical or possible physical assortment of falling objects of various sizes.

In a forthcoming paper I will elaborate upon the fact that no known geophysical force or combination of forces has been shown to produce an elliptical basin, and that no such force is or has been peculiar to the Carolina Plain.

Lastly, the only forces that can modify the surface of a celestial sphere are: 1. Bombardment from space; 2. Geophyiscal forces; 3. Biological agencies. If we can successfully disprove 1 and 2, and I believe it can be done, 3 only is left.

A very brief résumé of my biological hypothesis follows.

Inspection of photographs and study in the field show that the Bays are shallow ellipses that were excavated under a very shallow sheet of water which was flowing northeasterly. The wind was predominantly from the northwest, as is attested by the lowness of the beach ridges, and the presence of cold climate conifer pollen (from the Appalachians) contained in their deposits. Large schools of a now extinct species of fish swam up the main channels in order to spawn in places suitable to them. They needed shallow water away from the main channels so they spread over the shallows in schools. The bottoms of these shallows were not suitably deep or the texture was incorrect, so the fish stirred up the mud with fins, tail and/or gills. The gentle northeasterly current carried away the mud but the coarser quartz grains resettled in the form of rims. A fish must face oncoming waves when in shallow water—it cannot lie in the trough. These waves were coming from the northwest so the schools faced in that direction. The normal shape of any large aggregation of living animals in the open is elliptical.

Many species of fish existing today are mud-stirrers. Many species exist in schools of enormous numbers. The energy used by salmon

ascending from the sea to the headwaters of a river is enormous. No fish exist today which have habits exactly like those required for my solution, but neither do we see herds of dinosaurs roaming the earth. Bays do exist. Critics of this hypothesis have failed to offer a better solution, or any at all for that matter.

San Diego, California.

Tennyson, a Victorian Astronomer

By PAUL MOWBRAY WHEELER

Throughout the works of Alfred Tennyson numerous astronomical references are found, indicating a lively interest in this science. Apparently he was convinced that part of a minstrel's responsibility is to make his readers aware of the cosmos external to the earth. Part of the explanation for this attitude lies in Tennyson's personality, his early education, and home life; but the time was ripe for someone to sing of the stars.

The Nineteenth Century was distinguished by its astronomical discoveries. During these one hundred years more striking discoveries and inventions were recorded than had been made throughout the entire previous course of history. This was the age that produced one of the greatest astronomers of all time, Sir William Herschel (1738-1822) and his no less brilliant son, Sir John Frederick William (1792-1871). The great Munich optician, Joseph Von Fraunhofer, discovered the identity of the dark lines in the spectrum in 1815. Jean Bernard Foucault took the first photograph of the sun in 1845 and measured the velocity of light itself in 1862; and Giovanni Schiaparelli measured the rotation of Mercury in 1882 and discovered the "canals" of Mars in 1877. In 1870 an event occurred which must have attracted the attention of Tennyson: Richard A. Proctor pointed out the drifting movement among the fixed stars.

In 1856 Karl August Steinheil invented the process of silvering concave mirrors of glass. Up to that point speculum metal had been used. Telescopes began to grow in number and size, and a stimulating rivalry sprang up between the exponents of the two main types, refractors and reflectors.

Astronomical photography had its birth in 1840 when the first attempt was made to photograph the moon by J. W. Draper. Although Herschel had discovered binary stars in 1802, they were not photographed until 1857. But photography demonstrated its value most spectacularly in 1860 when the sun's chromosphere was recorded. In 1880 Draper again won distinction with his photographs of the nebula in Orion which Tennyson had been wondering about long since.

A single misty star
Which is the second in a line of stars
That seem a sword beneath a belt of three,
I never gazed upon it but I dreamt
Of some vast charm concluded in that star
To make fame nothing.[1]

To anyone who reads the works of Tennyson extensively it must become apparent that he was keenly aware of these advances that were being made. They suggested new ideas to his poetry and made it possible for him to add a freshness to his images which no other poet had attained by the same means. But this attitude was not just one of being impressed. He felt that his readers should be made aware of these new fields for emotion and imagination which had been opened, and he himself was not content to accept them as a mere layman but obviously studied them with much more care than the average reader for lack of time could devote to them. He could write easily of "sine and arc, spheroid and azimuth and right ascension,"[2] and as early as 1828 in a letter to his aunt, Mrs. Russell, he sententiously observed, "Wishes, I think, like telescopes reversed, seem to set their objects at a great distance."[3]

In the original version of "The Palace of Art" he showed his alertness to the awful complexity and vastness of the heavens which his scientific contemporaries were uncovering.

Hither, when all the deep unsounded skies
Shudder'd with silent stars, she clomb,
And as with optic glasses her keen eyes
Pierced thro' the mystic dome,

Regions of lucid matter taking forms,
Brushes of fire, hazy gleams,
Clusters and beds of worlds, and bee-like swarms
Of suns, and starry streams.

She saw the snowy poles and Moons of Mars,
That mystic field of drifted light
In mid Orion, and the married stars.[4]

He proved that he knew how the stars in the southern hemisphere are more loosely grouped in figures by referring to the "larger constellations burning, mellow moons and happy skies."[5] And he used the aurora borealis to serve in a somewhat florid turn of speech,

On her pallid cheek and forehead came
a color and a light,
As I have seen the rosy red flushing
in the northern night.[6]

In the school of "The Princess" there "were telescopes for azure views,"[7] and there is a passage in "In Memoriam" which shows he had heard of the startling use made of the spectrum by Fraunhofer, Fizeau, and Brewster.

When Science reaches forth her arms
To feel from world to world, and charms
Her secret from the latest moon.[8]

Tennyson's son tells us that in 1853 "my father would blow bubbles on feast days and then grow much excited over the 'gorgeous colors and landscapes, and the planets breaking off from their suns and the single star becoming a double star' which he saw in these bubbles."[9] In 1855 he had tea with guests and "looked at the nebulae in Cassiopeia [*sic*] through the big telescope [at the Bodleian?], the Ring Nebula in Lyra and also some double stars."[10] William Allingham on October 4, 1863, writes that "Tennyson takes me upstairs to his 'den' on the top story, and higher, up a ladder, to the leads. He often comes up here at night to look at the heavens."[11]

There are at least two references indirectly to Laplace's nebular hypothesis, which had been advanced first in 1796 to explain the origin of the solar system. One occurs in "The Princess":

This world was once a fluid haze of light
Till toward the centre set the starry tides,
And eddied into suns, that wheeling, cast
The planets; then the monster, then the man.[12]

The other passage is in "In Memoriam":

They say,
The solid earth whereon we tread

In tracts of fluent heat began,
And grew to seeming-random forms,
The seeming prey of cyclic storms,
Till at the last arose the man.[13]

It may be interesting to examine the poet's use of specific astronomical phenomena, and perhaps as practical a beginning as any can be made with meteors. When the earth passed through four swarms of shooting stars in 1866-1867, he could not have been unaware of the spectacular discovery of the relation between meteors and comets. Yet practically all his use of these transient celestial bodies is confined to his early verse. Most of these passages are in conventional tradition. Ganymede's isolation is compared to that of "a flying star shot through the sky,"[14] and Sir Launcelot's

helmet and helmet feather
Burn'd like one burning flame together,
As he rode down to Camelot;
As often thro' the purple night,
Below the starry clusters bright,
Some bearded meteor, trailing light,
Moves over still Shalott.[15]

Excalibur "flash'd and fell" "like a streamer of the northern morn,"[16] and over the departing lovers "many a sliding star and many a merry wind was borne."[17]

Referring to the fixed stars themselves, Tennyson has over two hun-

dred and twenty passages. He believes that the "poet in a golden clime was born with golden stars above,"[18] and his own eyes, like those of the lotos eaters, late in life grew "dim with gazing on the pilot-stars."[19] A speculation that many of us have indulged in at one time or another finds expression in "Sea Dreams":

> Then I saw one lovely star
> Larger and larger. "What a world," I thought,
> "To live in!"[20]

For him "the great stars that globed themselves in heaven"[21] are a source of constant inspiration.

To be sure, many of his images referring to them are characterized by the conventional sentimentality of the age. He uses, for instance, the stars to turn the hyperbole of a compliment as in,

> Thy sweet eyes brighten slowly close to mine,
> Ere yet they blind the stars, and the wild team
> Which love thee.[22]

Or he employs them to symbolize the apparent joy of nature as when

> The night-winds come and go . . .
> And the happy stars above them seem
> to brighten as they pass.[23]

The lover feels that the departure of his sweetheart has "taken the stars from the night and the sun from the day."[24]

But most of the poet's images carry enough originality to attract the reader's attention and often win his admiration. Some of these are short and simple. In a very early poem a character lies awake vainly seeking the solution of a problem while "one by one, the stars" go "down across the gleaming pane,"[25] and Jephthah's daughter sees "the large white stars rise one by one" and "God divide the night with flying flame, and thunder on the everlasting hills."[26] Sometimes the image is more extensive and challenging. Launcelot's bridle glitters "free, like to some branch of stars we see hung in the golden galaxy."[15] Or Tennyson may pray that the funeral ship which bears his friend's body "up from the under world"[27] be assured of a fair calm sea with weeping showers whose "balmy drops in summer dark slide from the bosom of the stars."[28] The fullness of his sweetheart's love may grow upon his awed contemplation "as though a star, in inmost heaven set . . . should slowly round his orb, and slowly grow to a full face."[29]

There are a few of these star-images that have won deserved recognition and are on the lips of Tennyson's admirers everywhere. Columbus' "golden guess" is "morning star to the full round of truth,"[30] and the lights are lit in the palace of art when "young night" crowns "dying day with stars."[14] Then, of course, there are the two famous passages: first, that which expresses Ulysses' purpose "to sail beyond the sunset, and baths of all the western stars, until" he dies;[31] second, the "sunset and evening star" of "Crossing the Bar."

We have here a poet who is impressed by the brightness, coldness, and multiplicity of the stars. Their indifference to our suffering can not be ignored. We proceed with our little lives while above us shake "the starry lights."[32] Over our comings and goings is "the deep sphere . . . distinct with vivid stars inlaid."[33] Who can "set apart their motions and their brightness from the stars?"[34] Sometimes they make the loneliness of the human soul more acute. Our cries may "shiver to the tingling stars."[35] "The chill stars sparkle;"[36] their very hardness and sharpness puncture our indifference and force us to "take wings of fancy, and ascend, and in a moment set" our faces "where all the starry heavens of space are sharpened to a needle's end."[37] And he who keeps his eyes upon the ground and pursues his selfish way, "a thousand suns will stream on" him, "a thousand moons will quiver."[38]

There are not many references to particular stars by name. We find one vivid comparison of a tower aflame to the aurora borealis as it shimmers through Ursa Major in "the live North red-pulsing up thro' Alioth and Alcor."[39] Cleopatra drinks "the Libyan Sun to sleep," and lights "lamps which outburn Canopus."[26] In his notes Tennyson refers to "the lesser wain . . . twisting round the Polar Star,"[40] and he observes that "the fiery Sirius alters hue."[41]

There are several constellations mentioned. Ulysses enjoys his voyaging "when thro' scudding drifts the rainy Hyades" vex "the dim sea."[31] The Gemini and the Charioteer are included in a quotation given below. "Charles Wain" comes "out above the tall white chimney-tops"[23] to watch the May Queen dance, and Gareth's glance is "allured" to Arthur's harp, Lyra.[112] There are other references to Charles Wain, or the Great Bear, one in connection with Arthur,

> Then came a night
> Still as the day was loud, and through the gap
> The seven clear stars of Arthur's Table Round—
> For, brother, so one night, because they roll
> Through such a round in heaven, we named the stars,
> Rejoicing in ourselves and in our King . . .
> And these, like bright eyes of familiar friends,
> In on him shone.[42]

Another occurs where the hero in "The Princess" "now poring on the glow-worm, now the star," paces "the terrace, till the Bear" has "wheeled through a great arc his seven slow suns."[43] The Prince also insists that he "would have reached" the Princess had she "been sphered up with Cassiopeia, or the enthroned Persephone in Hades."[44] Orion is the favorite constellation. Perhaps the best-known of all his references to it is the disappointed lover's recollection coupled with mention of the Pleiades.

> Many a night from yonder ivied casement, ere I went to rest,
> Did I look on great Orion sloping slowly to the west.
>
> Many a night I saw the Pleiads, rising thro' the mellow shade,
> Glitter like a swarm of fireflies tangled in a silver braid.[5]

At the end of "Maud" he uses Orion again, this time to identify the season of the year,

> When the face of night is fair on the dewey downs,
> And the shining daffodil dies, and the Charioteer
> And the starry Gemini hang like glorious crowns
> Over Orion's grave low down in the west.[45]

From 1840 to 1870 there were various spectacular solar eclipses visible in England and other parts of the British Empire. During the same period several important discoveries were made about "the nebulous star we call the sun."[46] In 1837 the younger Herschel measured the heat of the sun on the earth's surface and announced to the surprised world that only one part in 2,000,000,000 is intercepted by the surface of this globe. Humboldt proposed his theory of sunspot periodicity in 1851, and there were announcements by three separated astronomers in 1852 of the relation between sunspots and electrical disturbances. Helium was identified in the spectrum of the sun in 1868, though not discovered on earth until 1895 after Tennyson's death. Yet, in spite of all this publicity, Tennyson is not interested in this most intimate star except as a part of the backdrop of his poems or as a source of analogy.

There are over two hundred and fifty references to the "light of heaven"[47] many of which are such simple statements as "the sun is just about to set,"[48] and "as though you stood between the rainbow and the sun,"[48] and "the sun went down and the stars came out far over the summer sea."[49] Usually, however, the poet employs the sun in a comparison or in a personification. The "touch of all mischance" comes to his hero only

> As night to him that sitting on a hill
> Sees the midsummer, midnight, Norway sun
> Set into sunrise.[46]

The Battle of Bruanburh rages and blood flows

> from when first the great
> Sun-star of morning tide,
> Lamp of the Lord God
> Lord everlasting

glides "to his setting."[50] On another occasion the sun is "the captain of my dreams,"[26] and again he is the day itself;[51] and the magician in "Merlin and Vivien" "often o'er the sun's bright eye" draws "the vast eyelid of an inky cloud."[52] Sometimes the relation of man to the sun, "that wakest all to bliss or pain"[53] is stressed: in "The Passing of Arthur" desolation and death are freshened "by the new sun . . . bringing the new year."[54]

The most extensive use of the sun is in "Lucretius" and is so complicated with mythological and sensuous detail that longer quotation is probably in order:

Look, where another of our Gods, the Sun,
Apollo, Delius, or of older use
All-seeing Hyperion—what you will—
Has mounted yonder; since he never sware,
Except his wrath were wreak'd on wretched man,
That he would only shine among the dead
Hereafter—Tales! for never yet on earth
Could dead flesh creep, or bits of roasting ox
Moan round the spit—nor knows he what he sees;
King of the East altho' he seem, and girt
With song and flame and fragrance, slowly lifts
His golden feet on those empurpled stairs
That climb into the windy halls of heaven.
And here he glances on an eye new-born,
And gets for greeting but a wail of pain;
And here he stays upon a freezing orb
That fain would gaze upon him to the last;
And here upon a yellow eyelid fallen
And closed by those who mourn a friend in vain,
Not thankful that his troubles are no more.[55]

Judging by the number of his references, Tennyson likes the sun much better than the "moon that layest all to sleep again."[53] There are only about one hundred and fifty employments of the moon in his poetry. This is not a surprisingly large number for a poet whose attention must have been attracted by Plana's publication in 1832 of a very complete theory explaining our satellite and De Pontecoulant's advancement in 1846 of his famous lunar and planetary theory. Probably he was aware that the "New astronomy" had definitely characterized the moon as "dead." As an astronomical figure it had few challenging potentialities. It seemed serviceable only for the part it played in human activities. So he admits it only as a part of the background. And yet it was the moon that had the last word, for the night he died the windows of his room were open so that its light flooded in upon him.[56]

We must expect then that many of his references to the moon are merely means to point the time. "Love paces" "the thymy plots of Paradise . . . what time the mighty moon" is "gathering light."[57] An "amorous odorous wind" breathes "low between sunset and the moon"[29] upon Eleanore, and "at midnight, the moon cometh, and looketh down" upon lone Claribel.[58] Strength comes to Jephthah's daughter "when the next moon" is "rolled into the sky,"[26] and the wanderers seat themselves "between the sun and moon upon the shore"[19] of the Lotos Eaters' island. The Prince steals from the court of the Princess "ere the silver sickle of that month" becomes "her golden shield."[59] Thus the moon runs her "circle" like a clock to time our little wanderings.

Sun comes, moon comes,
Time slips away.
Sun sets, moon sets,
Love fix a day.[60]

But its light seems best adapted to show the transience of life, to intensify death and desolation and the passing of all things. Though

the spring is arriving, there is little warmth when "April's crescent" glimmers "cold."[61] It is when the moon is "setting and the dark" is "over all"[23] that the May Queen hears the angels of death calling her. Only after "the long day wanes" does the "slow moon"[31] come into her position. The lover knows well how the moon can remind one of the briefness of life,

> O, tell her, brief is life but love is long,
> And brief the sun of summer in the North,
> And brief the moon of beauty in the South.[46]

"The Passing of Arthur" has so many references to the moon that they attract the attention of even the most cursory reader. The "winter moon,"[62] twice so-called, falls upon the dead of the battlefield and upon the dying king; and the cries of Gawaine's ghost die away "far in the moonlit haze among the hills."[63] When Sir Bedivere draws Excalibur, "the great brand" makes "lightnings in the splendor of the moon;"[64] and "o'er him, drawing it, the winter moon, brightening the skirts of a long cloud," runs forth and sparkles "keen with frost against the hilt."[65] At the end of the poem only a comparison with the lifeless moon itself can picture the death impending in Arthur's countenance,

> For all his face was white and colorless
> And like the withered moon
> Smote by the fresh beam of the springing east,"[66]

and "on one side lay the ocean, and on one lay a great water, and the moon was full."[67]

Tennyson is fond of placing the moon in a watery setting. One of his unpublished lines speaks of "a full sea glazed with muffled moonlight,"[68] and a song in "The Princess" begins, "Ask me no more: the moon may draw the sea."[2] Even though the two actually may not be part of the same outlook, they associate themselves with each other,

> As in strange lands a traveller walking slow
> In doubt and great perplexity,
> A little before moonrise hears the low
> Moan of an unknown sea.[14]

Upon the mouth of Ida in "The Princess" "a doubtful smile" dwells "like a clouded moon in a still water."[2]

A few of the figures employing the moon are more vivid still. He who "toils across the middle moonlit nights"[34] may note "far heard beneath the moon"[26] "echo on echo"[69] dying to the "mellowed reflex of a winter moon."[70] In his anguish of soul Launcelot drives "along the dreary deep," and with him drives "the moon and all the stars."[71] Guinevere sees "the moony vapor rolling round the king,"[72] and "the balmy moon of blessed Israel"[26] shines upon Jephthah's daughter. The lovers "ere the night" rise and saunter "home beneath a moon, that, just in crescent" dimly rains "about the leaf twilights of airy silver."[73] The decline of the Round Table is "blurred by a creeping mist"

For all abroad
Beneath a moon unseen albeit at full,
The white mist, like a face-cloth to the face,
Clung to the dead earth, and the land was still.[74]

Nor should we allow the sheer simplicity of some of these passages to mislead us as to their deftness and beauty. To say, "There was but a slip of a moon"[75] may be deceptively direct and bare of superfluous ornament, and the picture of "the downs . . . as bright as day" where "the full moon stares at the snow"[76] grows upon the reader till he feels "the tender amber round which the moon about her spreadeth."[48]

It is noteworthy that Tennyson is very fond of the magnificent image in Ossian's work which for the most part he did not care for,

But behind thee was the Shadow of
Death, like the darkened half of the moon behind
Its other half in growing light.[77]

During Tennyson's life the solar system grew vastly. Arthur Berry in *A Short History of Astronomy*[78] asserts that "at the end of 1897 no less than 432 minor planets were known." Ceres was discovered in 1801. Vesta in 1807, and Juno in 1804. In 1781 Uranus was discovered, and in 1846 Neptune was located by Galle, although Adams had already placed the planet the year before. In 1857 Maxwell formulated his theory explaining the rings of Saturn. The rotation of Mars was established in 1864; and in 1877 Schiaparelli discovered the canals of Mars, as has already been pointed out above. It would seem that with this background, Tennyson would have had more references to planets in his verse. But Uranus, Jupiter, and Neptune are neglected; and Saturn rates one very observant comment,

Still as, while Saturn whirls, his steadfast shade
Sleeps on his luminous ring.[14]

Although various transits of Mercury were observed, the only reference to the planet is an ambiguous one and may as justly be assigned to Venus: The Princess, Tennyson says, was "like to the inhabitants of some clear planet close upon the sun."[12] When his son, Lionel, was born, Tennyson was "looking through the study window at the planet Mars 'as he glowed like a ruddy shield on the Lion's breast' and decided to give the name Lionel."[79] But Mars receives no attention in his poetry.

Venus, of which transits were extensively observed in 1874 and 1882, however, is his favorite planet, perhaps because of its association with love. But this "silver-smiling"[34] "sister world,"[80] which glows over "the dark shoulder"[80] of the "happy earth,"[80] even though, "smiling downward at this earthlier earth of ours closer on the sun," it may be "perhaps a world of never-fading flowers"[81] is not to be envied. If we were on Venus or Mars or some other planet, "we should see the globe we groan on, fairest of the Evening Stars,"[81] and speculate about it as we do now about Venus.

Various spectacular visitors from space came to call upon Victorian England. According to Berry[78] "more than 200 comets" were seen and measured during the nineteenth century. Some of the most famous of these were Pons' in 1884, Schaeberle's in 1881, Tebbutt's in 1881, Donati's in 1858, and Halley's in 1835. Liais discovered a double comet in 1860, and in 1872 there was a heavy meteoric shower from Biela's comet. On two occasions, moreover, in 1819 and 1861, the earth passed through the tail of a great comet. Particularly in October of 1858 the sight was "grand, with Arcturus shining brightly over the nucleus. . . They saw Arcturus seemingly dance as if mad when it passed out of the comet's tail." Tennyson remarked of the comet's tail that it was "like a besom of destruction sweeping the sky." His son recorded that he "observed the comet from his platform."[82] As a result the entire beginning of his drama *Harold* is colored by the great comet. The first act begins with the "comet seen through the open window," and the remarks of the characters lead us to believe that this is the seventh night "yon grimly-glaring, treble-brandished scourge" has appeared and that it has a triple tail like Comet 1947 *n* observed widely south of the equator during the closing days of 1947. They observe that "the star dances in it as mad with agony," and the "people . . . cannot speak for awe." Aside from this employment in his drama, however, there seem to be no other references to comets in the work of Tennyson.

What is the effect of all this interest and observation upon the philosophy and outlook of the poet? Do "the wanderings of this most intricate universe teach" him "the nothingness of things?"[83] Is the picture he sees hopeless in its last analysis, cold and bleak, a mere machine? It appears not. He admits that astronomy and geology are "terrible muses,"[84] that "the moonlight is the sunlight and the sun himself will pass."[81] He has his moments of questioning, like any other normal human being, when the "vast wastes of starless glooms" are "spread around in the chilling air"[85] and the stars seem sometimes to

> blindly run;
> A web is woven across the sky;
> From out waste places comes a cry,
> And murmurs from the dying sun.[86]

This, however, is not his normal, final, triumphant attitude learned of the firmament.

But he could not go to the other extreme and believe that man is the center of the universe. When he has read Whewell's *Plurality of Worlds,*[87] he writes in his journal,

> It is to me anything but a satisfactory book. It is inconceivable that the whole universe was merely created for us who live on this third-rate planet of a third-rate sun.[88]

Is it conceivable, he asks, to think that a human being represents the highest creation of God?

Think you this mould of hopes and fears
Could find not statelier than his peers
In yonder hundred million spheres?[89]

But the vastness of the universe is challengng to his thought and hope. It may be necessary sometimes, he cautions to "annihilate within yourself these two dreams of Space and Time."[90] Too close scrutiny can daze human conception, but the firmament which is "cloven with the million stars,"[91] "some that never set, but pass from sight and night to lose themselves in day,"[92] fills *him* with awe and inspiration.

The fires that arch this dusky dot—
Yon myriad-worlded way—
The vast sun-clusters' gathered blaze,
World-isles in lonely skies,
Whole heavens within themselves, amaze
Our brief humanities.[93]

When his elder brother, Fred, who was attending Eton, suffered from stage fright because he was obliged to make a speech, Tennyson advised him if he would think "of Herschel's great star-patches," he would "soon get over all that."[94]

He is "conversant with the relative position of the various constellations at different seasons." Moreover, he has "assimilated recent speculations as to the conditions of the moon and surmises about the planets as homes for living creatures." In short, he has "attained to a clear vision of the whole working of the solar system and its gradual decline."[95] But the fact that it is declining is not alarming to him. This is part of the vast scheme. He has glimpses of the possibilities beyond our earthly conception and is convinced that

The glory of the sum of things
Will flash along the chords and go.[96]

Everything seems to him part of a great plan, a unifying principle which "rolls a sphere of stars" about his "soul, in all her motion one with law."[97] He comes to believe completely in

That God, which ever lives and loves,
One God, one law, one element,
And one far-off divine event,
To which the whole creation moves.[98]

It is not conceivable to him that night should be the end, though "gradually the powers of the night, that range above the region of the wind, deepening the courts of twilight" may extend "thro' all the silent spaces of the worlds, beyond all thought into the heaven of heavens."[99] A scheme which could produce anything so wonderful as personality is capable of infinitely greater things. He hails the advent of his eldest son Hallam, as follows,

Out of the deep, my child, out of the deep,
From that great deep, before our world begins,
Wherein the Spirit of God moves as he will—
Out of the deep, my child, out of the deep,

> From that true world within the world we see,
> Whereof our world is but the bounding shore—
> Out of the deep, Spirit, out of the deep,
> With this ninth moon, that sends the hidden sun
> Down yon dark sea, thou cometh, darling boy.[100]

So when his contemporaries do not recognize great personality, he is disturbed. In his journal he laments "the want of reverence now-a-days for great men whose brightness shines like that of the luminous bodies in the Heaven, makes the dark spaces look the darker."[101]

Man's indifference to all this wonder above, beneath, around him Tennyson can not understand. He points out more than once the ridiculous picture of man self-blinded by his pride; and he urges his age to "look up thro' the night; the world is wide."[89] He decries the insignificant occupations of our lives and is particularly annoyed by the literary squabbles which mark his age.

> Ah, God! the petty fools of rhyme
> That shriek and sweat in pigmy wars
> Before the stony face of time
> And looked at by the silent stars.[102]

What may be called the summation of his credo is to be found in the immortal quatrain from "In Memoriam,"

> Our little systems have their day;
> They have their day and cease to be;
> They are but broken lights of thee,
> And thou, O Lord, art more than they.[103]

It is an interesting, if not inspiring, picture, this. Here is a poet who is charmed by the "great sphere-music of stars and constellations"[104] to lift his gaze toward bigger things. "Who knows the ways of the world," he asks, "how God will bring them about? Our planet is one, the suns are many, the world is wide."[105] And great though space may be, his thought surmounts it! "The peak is high, and the stars are high," but "the thought of man is higher."[106] It is not beyond his hope that some day soul may learn to commune with soul.

> Star to star vibrates light; may soul to soul
> Strike through a finer element of her own?[107]

That he may dare sometime to see the Power that planned and guides the universe is his greatest ambition; he yearns "for larger glimpses of that more than man which rules the heavens, and lights and lays the deep."[108]

As other poets before him have felt, he is disturbed by the lack of time and opportunity in this life to complete all that should be done, and he complains that there are "so many worlds, so much to do, so little done, such things to be."[109] Someday, when we have surpassed the restrictions of our present dimensions, we shall not be cabined by the limitations of time and space.

For was, and is, and will be, are but is,
And all creation is one act at once.[110]

And so we remember him, like Pelleas, with "peace at his heart and gazing at a star and marvelling what it was."[111]

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The Planets in January, 1949

By RAYMOND H. WILSON, JR.

NOTE: The time employed is Central Standard Time unless otherwise indicated. The phenomena have been chosen and described for the North American continent, and especially for the United States. The basic data have been taken principally from the *American Ephemeris and Nautical Almanac*.

Sun. January is usually the coldest month even though the sun is moving continuously northward from 23 degrees to about 17 degrees south of the equator. Another seeming paradox is that the earth in its annual orbit will be at perihelion, that is, closest to the sun, on January 3.

Moon. The phases of the moon will occur as follows:

First Quarter	January	7	6 A.M.
Full Moon		14	4 P.M.
Last Quarter		21	8 A.M.
New Moon		28	9 P.M.

The moon will be at perigee, that is, nearest to the earth, on January 16.

Evening and Morning Stars. Saturn will be rising in the late evening, and Venus in the early morning twilight.

Mercury. On January 17 Mercury will be at a maximum distance of 18 degrees east of the sun. It might be glimpsed low in the southwest after sunset on a few days around that date.

Venus. This brightest planet will be rising in the southeast dawn about an hour ahead of the sun.

Mars. Throughout this month Mars will be too close to the sun for practical observation.

Jupiter. Conjunction with the sun on New Year's Day will preclude observation of Jupiter during most of the month. However, an unusually close conjunction with Venus on the 26th might render it easily visible, just a few minutes of arc west of the other brighter planet.

Saturn. The ringed planet is coming into increasingly favorable aspect for evening observation. Being located in the constellation Leo, it will rise by 9 P.M. at the end of the month.

Uranus. Uranus will be moving westward, about 3 degrees northeast of ζ Tauri.

Neptune. Neptune will be almost stationary at a point about midway between Spica and γ Virginis.

Department of Mathematics, Temple University, Philadelphia, Pa.,
November 8, 1948.

Asteroid Notes

By HUGH S. RICE

PALLAS, whose positions were given in the last issue, is observable during December, and for some time after that if the observer follows it and plots the actual course as seen in the telescope. Besides this planet, we have only a few others available at this time, and they are not very bright for small telescopes. The subjoined ephemerides give the places of planets 704, 182, 19, and 95. 704 is in Auriga, within the pentagon of stars, while the others are near the Taurus-Orion-Gemini border. The visual magnitudes are, respectively, about 9, 9, 9, and 10.

ASTEROID EPHEMERIDES

For 0^h U.T. Equinox 1950

704 INTERAMNIA

1948-49	α h m	δ ° ′
Nov. 25	5 36.4	+34 1
Dec. 3	5 28.6	+33 23
11	5 20.3	+32 36
19	5 12.0	+31 41
27	5 4.4	+30 41
Jan. 4	4 58.3	+29 39
12	4 54.6	+28 37

182 ELSA

1948-49	α h m	δ ° ′
Nov. 25	6 6.2	+21 37
Dec. 3	6 0.1	+21 44
11	5 52.5	+21 53
19	5 44.1	+22 2
27	5 35.8	+22 11
Jan. 4	5 28.7	+22 19
12	5 19.1	+22 26

19 FORTUNA

1948-49	α h m	δ ° ′
Nov. 25	6 9.8	+21 26
Dec. 3	6 3.2	+21 19
11	5 55.2	+21 12
19	5 46.6	+21 5
27	5 38.2	+20 59
Jan. 4	5 30.7	+20 55
12	5 24.8	+20 52

95 ARETHUSA

1948-49	α h m	δ ° ′
Nov. 25	6 36.5	+15 46
Dec. 3	6 32.0	+15 0
11	6 26.0	+14 20
19	6 19.1	+13 45
27	6 11.9	+13 16
Jan. 4	6 4.8	+12 52
12	5 58.5	+12 35

Hayden Planetarium, American Museum of Natural History,
New York, N. Y., 1948 November 21.

Occultations for January, 1949

(Taken from the *Amerian Ephemeris*)

Date 1949	Star	Mag.	IMMERSION Greenwich C.T. h m	IMMERSION a m	IMMERSION b m	IMMERSION Angle E from N °	EMERSION Greenwich C.T. h m	EMERSION a m	EMERSION b m	EMERSION Angle E from N °
OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′										
Jan. 4	ψ^2 Aqar	4.6	21 23.7	−2.1	+0.4	75	22 39.5	−0.7	+1.3	204
5	29 Pisc	5.2	23 36.4	+0.9	+4.3	348	0 12.0	−3.1	−3.6	294
7	263 B.Pisc	6.4	23 30.4	−1.8	+0.9	60	0 53.2	−1.3	+1.0	224
10	54 Arie	6.5	3 57.8	−1.2	−2.2	106	4 56.8	−1.0	+0.8	215
11	32 Taur	5.8	1 2.9	−2.6	−0.9	109	2 4.1	−1.2	+3.0	203
18	308 B.Leon	5.9	8 37.3	−1.0	−1.7	144	9 46.7	−1.4	−1.3	292
20	91 G.Virg	6.5	5 35.4	−1.6	+4.4	57	6 0.6	+0.6	−4.0	10

Date 1949	Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
			h m	m	m	°	h m	m	m	°
	OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′									
Jan. 3	154 B.Capr	6.1	0 4.3	—1.9	—2.0	103	0 52.9	+0.4	+1.6	190
6	4 Ceti	6.3	3 1.9	—1.8	—4.0	117	3 35.6	+0.3	+3.6	177
6	5 Ceti	6.3	3 19.5	—1.3	—2.9	109	4 0.9	+0.1	+2.4	183
7	155 B.Pisc	6.5	3 56.1	—0.9	—0.9	78	5 0.3	—0.3	+0.3	222
7	263 B.Pisc	6.4	22 59.7	—1.0	+2.3	32	0 20.2	—2.0	+1.0	247
10	54 Arie	6.5	3 30.0	—2.4	—2.1	109	4 30.1	—1.3	+2.4	202
11	32 Taur	5.8	0 22.0	—1.6	+1.2	84	1 34.9	—1.2	+2.3	220
18	308 B.Leon	5.9	8 35.7	..	..	196	9 4.3	—4.2	+3.0	240
	OCCULTATIONS VISIBLE IN LONGITUDE +98° 0′, LATITUDE +31° 0′									
Jan. 3	154 B.Capr	6.1	0 10.6	..	..	128	0 32.8	..	..	162
7	155 B.Pisc	6.5	4 2.6	—1.8	—3.1	112	5 44.2	—0.2	+3.4	186
7	263 B.Pisc	6.4	22 31.6	—0.9	+2.4	35	23 54.2	—2.0	+1.6	240
11	32 Taur	5.8	0 0.9	—1.7	+0.9	94	1 4.3	—0.6	+3.0	207
	OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′									
Jan. 6	4 Ceti	6.3	2 4.7	—2.3	+0.3	72	3 21.6	—0.7	+1.7	204
6	5 Ceti	6.3	2 31.6	—2.1	0.0	73	3 46.6	—0.7	+1.5	205
7	155 B.Pisc	6.5	3 16.5	—1.7	+0.7	57	4 38.7	—1.1	+0.7	226
10	54 Arie	6.5	2 18.9	—1.9	+1.4	72	3 40.1	—1.5	+2.2	221
10	32 Taur	5.8	23 53.9	0.0	+2.0	46	0 55.4	—0.9	+1.4	260

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

These Notes contain the statistical results for 1948 so far reported by our members and others on which a study of daily rates can be based, except for the reports of Tommy Scott of Nauvoo, Ala., and of our correspondents and members abroad which will appear later as they, of themselves, would fill up half as much space again as the following tables. Table A contains reports covering the Perseid epoch only, made mostly by persons not A.M.S. members, and none of whom plotted the meteors seen. The results are either hourly or half-hourly counts, or tables with data on the separate meteors. Hence rates in Table A per force, for all other things equal, should be higher than those in Table B, in which, for many observers, all or at least a large part of the meteors were plotted. In A, as many obsevers were untrained, naturally some data were omitted.

Corresponding spaces have hence been left blank in the Table. In column 8, F, is given the factor for the night, supposed to give the clearness of the sky, 1.0 being perfect. In most cases observers are likely to overestimate the transparency, by not making enough allowance for moonlight, haze, etc. When their notes permit, or I know that the Moon was visible, I have not hesitated to lower F when it seemed necessary. Column 9 gives the observed or uncorrected rate. To secure the corrected rate this number must be divided by F. Column 10 gives the number of observers. When there were more than one sending in a single report, comparable rates cannot safely be derived. It is most difficult to induce many people to make wholly separate counts, though often this has been urged upon them. The last column uses the letters C, D, and P, which mean, respectively, that the meteors were counted, separately described, or described and plotted. Fewer persons participated in observing the Perseids than usual, partly due to bad weather conditions over much of the country, partly perhaps to less publicity in the press. The 1948 return of this stream indeed seems to have been poorer than usual, nevertheless where people were favored by excellent skies, as some in Oregon and Texas, rates of from 40 to 60 per hour were obtained. But it was certainly far below the return of 1944.

In Table B are found the regular reports. Here the rates are cut down sharply by the time lost as each meteor is plotted and recorded. As the writer found it took him 40 seconds to do this, even in years when he observed meteors a great deal and was in full practice, it is certain that the average observer loses fully one minute for each meteor and those of small experience probably lose two minutes. Such facts should be allowed for in statistical discussions of rates. One of our troubles, even with member observers, to say nothing of others, is that some do not give the double date for the night. If the observing is done after midnight, this often leads to ambiguity. In fact, in several cases in both A and B, I am not yet sure whether I correctly interpreted the given date. In our publications we always use the old astronomical date, *i.e.*, keep the date for the whole night as that on which it began. The kind of time used is also often omitted, as well as notes on the sky. Others omit giving when observations begin and end, seeming to think that when the first and last meteor was recorded is all that is needed. Reforms in all these matters are easy and would save me much trouble and would add to the value of many reports.

During 1948 Jeremy H. Knowles of Marblehead, Mass., is the observer who has made special progress and soon may be counted among our handful of really good and fully trained observers. This does not imply that many others are not doing well, but his record of 619 meteors, practically all plotted and fully recorded in the first ten months of the year deserves special approbation. It will be seen that considerable work has been done in North Carolina. This is largely due to the efforts and enthusiasm of F. B. Eason of Wilson, N. C., who has been acting very efficiently as assistant regional director for that state. I have not had time as yet to work up most of the radiants probably to be found from the maps of persons mentioned in Table B, but doubtless a good number will be determined. Table B is arranged alphabetically according to observers.

TABLE A

Station, Observer, and Time	Date 1948	Began	Ended	Min.	Met.	F	Rate	Obs.	C
Silverton, Ore.—P.S.T.									
Jensen, Miss Alice K.	7 31	13:30	14:30	60	19	0.8	19	1	c
" "	8 10	14:10	15:05	55	25	0.6	27	1	c
" "	8 11	14:05	15:05	60	58	1.0	58	1	c
" "		15:05	15:50	45	48	0.7	64	1	c
" "	8 12	13:45	15:10	30	16	0.4	32	1	c
" "	15	13:15	15:10	55	19	0.5	21	1	c
Pierre, S. D.—C.S.T.									
Hyde, Mrs. F. L.	8 11	15:15	16:15	60	83		..	3	c
Tuscon, Ariz.—M.S.T.									
Burlinson, M. A.	8 12	13:00	14:00	60	8	0.6	8	1	c
Burlinson, Mrs. L. O.	8 12	13:00	14:00	60	14	0.6	14	1	c
Saco, Maine									
Graves, Mrs. S. B.	8 10	11:00	12:30	90	17		11	1	c
" "		16:00	16:20	20	18	0.9	54	1	c
" "	8 11	9:30	10:45	75	6	0.2	..	1	c
Moylan, Pa.									
Karsner, Mrs. K. H.	8 10	12:37	13:25	?	16		..	1	c
Elkins Park, Pa.									
Kirk, Mrs. J. G.	8 10	12:00	12:50	50	8		10	2	b
Wrightstown, Pa.									
Blatchley, A.	8 10	11:00	12:30	90	16	0.7	11	1	b
Wilkes-Barre, Pa.									
Banningartner, L. M.	8 10	11:25	12:12	?	6		..	1	b
South Easton, Mass.—E.S.T.									
Skinner, G. B.	8 10	8:50	11:05	135	20	1.0	9	1	b
Sarasota Springs, N. Y.									
Kennedy, Miss M. C.	8 10	11:50	13:00	75	23	0.5	18	1	c
Cranberry Isle, Maine									
Christensen, D.	8 10	12:05	13:05	60	50	1.0	..	2	c
Melrose Park, Pa.									
Robinson, N.	8 9	11:15	13:05	100	20		12	1	c
" "	8 11	11:15	13:15	120	12		6	1	c
Burlington, Texas									
Jarrell, Miss V.	8 11?	12:00	13:00	60	83		..	2	c
Waco, Texas									
Hickey, T. F.	8 11?			60	78		78	1	c
Jenkins, Miss N. J.	8 11	12:00	13:00	60	60		..	2	c
McGlasson, Miss M. A.	8 11	11:30	16:00	270	89		20	1	c
Miller, Miss M.	8 11	12:00	14:00	120	67		34	1	c
Neubauer, Miss A.	8 11	12:00	14:00	120	54		27	1	c
Koch, Miss S.	8 11?	11:30	14:00	150	103		41	1	c
Grants Pass, Ore.									
Thompson, Mrs. F.	8 10	12:45	13:45	60	22		22	1	c
" "	8 11	13:45	14:45	60	23		23	1	c
Salem, Ore.									
Graham, J. W.	8 11	9:50	10:50	60	17	0.6	..	3	c
Graham, J. L.	8 11	13:22	14:22	60	53	1.0	53	1	c
Kerrsville, Texas									
Des Roches, Dr. J. B.	8 11	12:11	13:02		21		..	2	b
Couch, Mrs. D.	8 11	11:05	12:08	63	22		21	1	b
Kemper, Father	8 10	12:25	13:30	65	11		10	1	c
" "	12	11:20	13:05	105	24		14	1	b
" "	13	13:35	14:05	30	1	...	2	1	c
Strugham, E.	13	12:27	13:27	60	17	1.0	17	1	c
Yakima, Wash.—P.S.T.									
Newsman, E. J.	8 12	9:30	12:00	150	43		..	2	c
Philadelphia, Pa.									
Pachor, Mrs. J. R.	8 10	12:15	13:17	62	10		..	2	b

TABLE B

Station, Observer, and Time	Date 1948	Began	Ended	Min.	Met.	F	Rate	Obs.	C
East Haven, Conn.—E.S.T.									
Anyzeski, V.	1 11	9:45	11:00	75	5	1.0	4	1	P
" "	14	6:30	11:00	165	11	0.8	4	1	P
" "	29	7:45	9:00	75	4	0.9	3	1	P
" "	30	7:40	9:40	120	18	1.0	9	1	P
" "	31	7:45	9:45	120	12	0.9	6	1	P
" "	2 1	8:50	10:20	90	8	0.6	5	1	P
" "	9	7:45	9:15	90	7	0.6	5	1	P
Laramie, Wyo.—M.S.T.									
Beetle, Mrs. D.	8 10	13:05	14:11	66	21	0.9	19	1	P
Buhl, Idaho									
Brannen, Mrs. D. C.	11	14:35	15:35	60	40		40	1	C
Wilson, N. C.—E.S.T.									
Braswell, D.	8 6	10:20	13:50	210	43	0.8	12	1	D
" "	8	12:00	13:00	60	9	0.8	9	1	D
" "	9	11:00	12:15	75	10	0.8	8	1	D
" "	10	8:54	12:30	216	22	0.8	6	1	D
" "	11	11:00	14:04	184	70	0.6	23	1	D
" "	12	9:45	11:20	95	9	0.4	6	1	D
Pasadena, Calif.									
Buddhue, J. D.	8 11	13:13	14:30	77	10	0.7	12	1	D
Spring Valley, N. Y.—E.S.T.									
Burns, H. A.	4 10	9:58	11:58	120	8	1.0	4	1	P
" "	10	12:40	13:10	30	0	1.0	0	1	
" "	18	13:40	14:55	75	6	1.0	5	1	P
" "	5 2	14:00	15:00	60	3	0.7	3	1	P
" "	8 9	14:00	15:50	110	21	0.5	11	1	P
" "	10	9:56	12:56	180	33	0.6	11	1	P
" "	15	14:16	15:52	96	14	1.0	9	1	P
" "	16	14:35	15:35	60	4	0.3	4	1	C
Columbia, Ky.—C.S.T.									
Bybee, G. F.	2 21	8:00	10:30	150	11	0.8	4	1	P
" "	28	7:30	9:10	100	9	0.8	5	1	P
" "	29	7:00	8:30	90	7	0.7	5	1	P
" "	4 2	8:00	9:15	75	5	0.8	4	1	P
" "	17	7:30	8:45	75	4	0.6	3	1	P
" "	24	7:30	8:45	75	6	0.7	5	1	P
" "	25	7:30	10:40	190	12	0.9	4	1	P
" "	5 9	9:00	10:30	90	8	0.8	5	1	P
" "	30	9:00	10:30	90	4	0.5	3	1	P
" "	6 10	9:00	10:00	60	5	0.8	5	1	P
" "	13	9:00	11:00	120	10	0.7	5	1	P
" "	7 4	9:00	11:00	120	8	0.7	4	1	P
Bronx, N. Y.—E.S.T.									
Chabot, H. L.	7 3	10:45	11:15	30	2	0.5	4	1	P
" "	10	9:30	11:45	120	8	0.7	4	1	P
Orange Co., N. Y.—E.S.T.									
Chabot, H. L.	8 7	11:00	12:00	60	7	0.9	7	1	P
" "	9	10:10	12:10	120	18	0.8	9	1	P
" "	10	12:00	14:00	120	34	0.9	17	1	P
Cape Elizabeth, Maine—E.S.T.									
Dole, R. M.	1 3	13:00	14:30	90	48	0.7	32	1	P
" "	4 19	8:00	10:00	120	0	1.0	0	1	
" "	20	8:00	10:00	120	0	1.0	0	1	
" "	21	8:00	10:00	120	0	1.0	0	1	
" "	6 28	9:00	10:00	60	0		0	1	
" "	29	9:00	10:00	60	4	0.9	4	1	P
" "	30	9:00	10:00	60	0		0	1	
" "	7 28	9:	13:30	?	28	0.6	?	1	P

Station, Observer, and Time	Date 1948	Began	Ended	Min.	Met.	F	Rate	Obs.	C
Cape Elizabeth, Maine—E.S.T.									
Dole, R. M.	8 10	13:00	14:00	60	18		18	1	P
" "	12	8:30	11:00	90	23		16	1	P
" "	25	7:45	8:45	60	11	1.0	11	1	P
Strafford, N. H.—E.S.T.									
Dupee, Mrs. D. S.	8 10	9:30	13:45	170	42	0.6	15	1	D
" "	10 18	12:00	13:00	60	2	0.5	2	1	D
" "	21	10:25	11:55	90	2		2	1	D
" "	11 1	10:05	12:35	150	23	0.7	9	1	D
Wilson, N. C.—E.S.T.									
Eason, Mrs. G. B.	8 6	10:20	12:45	145	14	1.0	6	1	D
" "	7	11:20	11:59	39	4	0.3	..	1	D
" "	9	10:25	11:30	65	6	1.0	6	1	D
" "	11	10:15	12:50	155	13	0.7	5	1	D
" "	12	10:15	11:00	45	4	0.7	5	1	D
Eason, F. B.	7 30	10:45	13:25	100	16	0.9	10	1	D
" "	31	11:30	14:00	150	11	0.9	4	1	D
" "	8 4	13:00	14:00	60	6	0.4	6	1	D
" "	6	10:20	14:20	240	31	1.0	8	1	D
" "	7	11:20	13:50	150	11	0.4	4	1	D
" "	9	8:30	14:30	360	34	1.0	6	1	D
" "	10	8:25	16:00	455	20	0.5	..	1	D
" "	11	8:20	16:15	475	50	0.7	6	1	D
" "	12	8:30	16:00	450	71	0.7	9	1	D
Central Park, N.Y.C.—E.S.T.									
Fein, L.	8 13	9:30	14:15	285	33		7	1	P
Greenville, S. C.									
Field, R. J.	8 12	14:00	16:00	120	19	0.8	10	1	P
" "	13	14:00	15:00	60	9	0.8	9	1	P
Sibley, Iowa—C.S.T.									
Fitzsimmons, C. S.	4 20	11:00	12:30	90	2	0.4	..	1	C
" "	7 27	10:30	12:00	90	12	1.0	8	1	C
" "	29	10:30	12:30	120	14	1.0	7	1	C
" "	8 9	11:00	12:30	90	27	1.0	18	1	C
" "	10	10:50	13:40	170	36	0.7	13	1	C
" "	13	10:30	12:30	120	21	0.7	10	1	C
Fall Brook, Calif.									
Forsyth, E. L.	4 20	6:45	9:15		0		0		C
" "	23	6:45	9:30		0		0		C
" "	24	7:	9:35		0		0		C
" "	25	7:	9:		0		0		C
" "	5 3	13:30	15:30	120	5		2	1	D
Milton, Pa.—E.S.T.									
Gorson, R. O.	8 7	11:18	16:00	282	81	0.6	..	3	F
Pittsfield, Mass.—E.S.T.									
Green, G.	7 1	11:51	13:30	99	7	1.0	4	1	PD
" "	2	10:15	14:00	225	26	0.8	7	1	PD
Sarasota, Fla.—E.S.T.									
Griffith, Miss J.	8 12	11:52	14:45	173	26	0.4	..	1	P
Scotch Plains, N. J.—E.S.T.									
Griswold, D. E.	8 6	12:15	13:30	75	10	0.7	8	1	D
" "	7	12:15	14:00	105	19	0.7	11	1	D
" "	10	13:25	14:25	46	19	0.7	25	1	D
" "	11	11:25	13:05	90	27	0.7	18	1	D
Joliet, Ill.									
Joliet Astr. Soc.:									
Preucil, F.	8 10	10:00	13:00	120	33		16	1	C
Price, R.	10	9:00	11:00	120	34		17	1	C
Preucil, F.	11	10:00	11:00	60	4		4	1	C
Price, R.	11	9:00	11:00	120	11		6	1	C
Cervin, F.	11	9:00	11:00	120	9		4	1	C

Station, Observer, and Time	Date 1948	Began	Ended	Min.	Met.	F	Rate	Obs.	C
Marblehead, Mass.—E.S.T.									
Knowles, J. H.	5 1				8			1	P
" "	6 29	9:	11:	120	4	0.9	2	1	P
" "	30	9:	11:	120	4	0.9	2	1	P
" "	7 15	12:30	14:30	120	15	1.0	8	1	P
" "	28	13:00	15:00	120	13	0.7	6	1	P
" "	31	12:30	15:30	180	21	0.6	7	1	P
" "	8 6	12:15	15:15	180	55	1.0	18	1	P
" "	7	12:15	15:15	180	32	0.8	11	1	P
" "	9	12:15	15:15	180	46	0.6	15	1	P
" "	10	12:00	15:30	210	66	1.0	19	1	P
" "	13	12:00	15:35	215	52	1.0	15	1	P
" "	14	13:00	15:30	150	47	1.0	19	1	P
" "	15	13:00	15:15	135	35	0.8	16	1	P
" "	29	13:20	15:35	135	17	1.0	8	1	P
" "	9 1	13:00	15:00	120	22	0.8	11	1	P
" "	3	13:00	15:00	120	10	0.7	5	1	P
" "	4	13:00	15:30	150	19	0.9	8	1	P
" "	5	13:00	15:00	120	6	0.9	3	1	P
" "	10 15	14:40	16:50	130	23	0.5	11	1	P
" "	28	13:00	15:00	120	28	0.9	14	1	P
" "	29	13:00	16:00	180	23	0.8	8	1	P
" "	30	13:00	16:00	180	30	1.0	10	1	P
Parkway, N.Y.C.—E.S.T.									
Lee, R.	7 10	9:16	11:22	?	7	0.7	..	1	P
" "	8 13	9:58	11:11	?	4	0.7	..	1	P
" "	14	9:30	14:20	290	21	0.8	4	1	P
" "	15	8:15	15:15	420	26	1.0	4	1	P
Schenectady, N. Y.—E.S.T.									
Liston, M.	8 10	11:30	15:30	240	45	1.0	11	1	P
Beatrice, Nebr.									
Mains, M. M.	4 19	8:15	9:15	60	6	0.5	6	1	C
" "	20	8:15	9:15	60	0	0.4	0	1	C
Birmingham, Ala.—C.S.T.									
MacQueen, Dr. J. W.	9 20	6:30	7:15	45	2	0.5	3	1	P
" "	23	7:45	8:30	45	3		4	1	P
" "	30	7:00	8:00	60	0		0	1	P
" "	10 8	7:30	8:30	60	1		1	1	P
Buhl, Idaho									
Sandmeyer, Miss E.	8 10	10:	11:	60	18		18	1	C
" "	11	10:	11:	60	20		20	1	C
" "	11	15:55	16:25	30	29		58	1	C
Batavia, Ill.—C.S.T.									
Siekman, Wm. J.	8 11	11:30	15:30	240	111	1.0	28	1	P
" "	13	11:30	15:00	210	72	0.5	21	1	P
Apex, N. C.—E.S.T.									
Seagraves, D.	4 17	12:00	16:50	290	15	1.0	3	1	P
" "	6 5	10:00	15:00	300	11	1.0	2	1	P
" "	7 31	10:00	12:00	112	12	1.0	6	1	P
" "	8 12	15:00	17:00	19	120	?	10	1	P
λ 117° 38′ W, ϕ 34° 17′, altitude 8800 feet									
Silvernath, C. J.	8 11	11:14	13:16	120	58	1.0	29	1	CP
" "		13:29	15:31	120	64	1.0	32	1	CP
Brockton, Mass.—E.S.T.									
Skinner, G. B.	10 9	9:00	10:00	60	7	1.0	7	1	C
Brooklyn, N. Y.—E.S.T.									
Spagnoli, J. D.	8 10	9:30	11:00	90	9	0.9	6	1	P
Elkhart, Ind.—E.S.T.									
Swihart, T.	8 13	14:00	16:00	120	23	0.8	12	1	P

Station, Observer, and Time	Date 1948	Began	Ended	Min.	Met.	F	Rate	Obs.	C
Seymour, Conn.—E.S.T.									
Tifft, W. G.	9 6	9:00	10:00	60	17	1.0	17	1	C
" "	10 29	9:25	10:25	60	21		21	1	C
Seal Harbor, Maine—E.S.T.									
Turnbull, H. S.	3 29	7:23	8:39	76	6	1.0	5	1	D
" "	8 26	7:40	9:45	125	20	1.0	10	1	D
Ratliff, Okla.—C.S.T.									
Veal, H. K.	7 5	9:04	10:04	60	14	0.9	14	1	P
" "	8 5	8:50	10:10	80	27	0.9	20	1	P
" "	6	9:40	10:30	110	8	0.4	4	1	P
" "	9	9:09	10:09	60	21	1.0	21	1	P
" "	10	10:59	13:08	129	52	1.0	24	1	P
" "	11	9:35	10:35	60	16	0.4	16	1	P
" "	13	9:05	10:15	70	15	0.9	13	1	P
" "	19	9:16	10:36	80	15	1.0	11	1	P
" "	20	9:45	11:05	80	21	1.0	16	1	P
Bronx, N. Y.—E.S.T.									
Weitzenhoffer, K.	7 24	12:00	13:00	60	5	0.6	5	1	D
" "	31	10:30	11:30	60	3	0.8	3	1	D
" "	8 9	13:10	15:10	120	7	0.6	4	1	D
" "	10	13:05	14:35	80	10	0.5	8	1	D
" "	13	12:20	13:20	60	6		6	1	D
" "	14	10:50	15:15	?	33	0.8	?	1	DP
Pleona, Ind.—C.S.T.									
Wright, M. G.	8 13	13:00	15:00	120	51	1.0	26	1	PD
" "	14	13:00	14:54	114	57	0.8	30	1	PD
Portland, Ore.—P.S.T.									
Widmer, R.	8 7	9:15	10:45	90	19	0.8	13	1	D
" "	10	11:00	13:00	60	20	0.8	20	1	D
" "	11	10:00	11:30	90	48	0.9	32	1	D
Clinton, Mass.—E.S.T.									
Whipple, B.	5 1	13:00	15:00	120	8		4	1	D
Marblehead, Mass.—E.S.T.									
Whipple, B.	7 28	13:00	15:00	120	12	0.8	6	1	D
" "	31	12:35	15:35	180	34	0.7	11	1	D
" "	8 10	12:10	15:40	210	97	1.0	28	1	D
Ottumwa, Iowa—C.S.T.									
Worley, C. E.	7 17	10:01	10:15	?	3	1.0	..	1	D
" "	23	9:25	9:55	?	6	1.0	..	1	P
" "	24	10:01	10:55	?	5	1.0	..	1	P
" "	25	9:00	10:43	?	11	1.0	..	1	P
" "	7 26	10:20	11:45	85	28	1.0	..	2	P
" "	27	8:30	11:30	180	40	1.0	..	2	P
" "	8 9	8:30	9:30	60	4	0.8	..	2	P
" "	10	8:30	11:30	180	30	0.8	..	3	P
" "	11	8:30	14:30	360	123	0.8	..	3	P
" "	12	8:05	12:00	235	50	0.7	13	1	P

Flower Observatory of the University of Pennsylvania, Upper Darby, Pa. 1948 Nov. 10.

Contributions of The Meteoritical Society

(Known Formerly as The Society for Research on Meteorites)

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A New Glass of Possibly Extraterrestrial Origin*

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ABSTRACT

This paper records the discovery, in Val Verde County, on the Rio Grande in Texas, of 350 remarkably symmetrical specimens of natural glass resembling certain forms of tektites—particularly australites. The distribution of the specimens in a small elliptical area far removed from any evidence of volcanic action, as well as certain features of the specimens themselves, suggests for them a possibly extraterrestrial origin, tho they exhibit certain features which set them definitely apart from other specimens ordinarily accepted as belonging in the category of tektites.

Early in 1941, Mr. Orville Lee, of Del Rio, Texas, reported to me his discovery of several hundred small specimens of natural glass, of unusual form and appearance, in Val Verde County, about 4 miles northwest of Del Rio. He described the locality where the specimens were found as follows:

"The area happens to be on top of a limestone formation—low hills or a divide. There is no certain place in this area to find the specimens. There is some gravel and a little sand on top of the lime, but you find some in the sand or gravel, and some in places where there is no soil, and where there is just lime rock, you find some; so the formation or the soil has nothing to do with them. They are just in a certain area, which happens to be on top of a mesa or divide, and not in a valley.

"I do not think, or I am positive, they do not weather out of any formation, and they appear to be only on top of the soil or formation. There are no wind blow-outs, and the soil is subject only to the average erosion of the weathering agents."

In another report, Mr. Lee stated that all the specimens had come from an elliptical area, about 2 miles long and ¾ths of a mile wide, extending from southeast to northwest, and that most of the specimens, including the larger ones, had been found at the northwest end. This distribution is noted because of the manner in which it parallels the distribution of meteoritic showers.[1] Del Rio is in a region of Cretaceous and Eocene formations, on the Rio Grande, about 120 miles east of the Big Bend area.[2] The nearest volcanic rocks of Quaternary times are more than 300 miles away—in northern Chihuahua, near El Paso, and in central Tamaulipas.[3] The nearest volcanic rocks of older age are more than 100 miles directly west of Del Rio. There are 350 specimens, ranging in weight from ¼ gm. to 32 gm., in the collection which Mr. Lee submitted for my examination. Remarkably symmetrical in form, they are predominantly lenses, either

*The revision of a paper originally entitled "Tektites in the United States," read at the 10th Meeting of the Society, San Diego, California, 1947 June 18-19.

circular or elongated, resembling one of the common forms of australites. Some of the lenses are widely elliptical when viewed edgewise; others are much flattened. A few ellipsoids and capsular shapes occur, as do also a very few quasi-spatulate forms and almost perfect spheres. These specimens, which I shall call *valverdites*, exhibit various features which set them definitely apart from other specimens commonly accepted as belonging in the category of tektites. As determined by Dr. Lincoln La Paz, they fuse readily into a frothy mass under a blowpipe flame; they have an index of refraction which averages about 1.48; and they have a density which averages 2.30. Even more notable from the standpoint of differences is the fact that they contain many crystals, ranging in size from microscopic trichites to megascopic crystals almost 2 mm. in diameter. These qualities indicate that valverdites are composed of a rather high-silica glass, closely resembling the glass in obsidian.

Suess defined tektites as "bodies which, in contrast to other meteorites, are completely melted materials."[4] In all probability, he intended that the term should be applied to any glass of extraterrestrial origin, regardless of its physical and chemical properties. As now commonly used, however, the term applies to specimens of natural glass which in composition associate themselves with certain sedimentary rocks, whereas obsidian is related to magmatic rocks.[5] Tektites are widely assumed to be of extraterrestrial origin, for no other reason than that no better explanation has been found to account for them! There is a tendency, however, to ignore the fact that in various parts of the world other varieties of glass have been found which also are difficult to explain. Libyan Desert glass and Darwin glass are two of them, tho La Paz holds that Darwin glass should be classified with impactites, such as Wabar glass.[6] Another specimen which differs widely has been found in southern Sweden.[7] More significant in the present discussion are the specimens of natural glass found in Colombia and Peru, to which Martin has given the name of *americanites*. These specimens occur over many hundreds of square miles, mainly on the tops of hills, in a region devoid of volcanoes and bedrock obsidian.[8] In chemical composition they correspond closely to obsidian, but in gas content they differ widely therefrom. They contain mainly CO_2, CO, and H_2, which are strongly present also in tektites. No chlorine or sulfur gases, which characterize obsidian, are present.[9] Like the valverdites, they contain crystals. In certain localities in the Philippines, typical tektites and specimens of obsidian-type glass are found together, according to Koomans, who states that they bear a very close resemblance to one another in color and in surface sculpturing.[10] That they have different origins is assumed, because they have different compositions. There is a likelihood that valverdites are rather closely related to americanites. In external appearance, however, they differ very noticeably. While the americanites are rounded, they lack the symmetry and common conformity of valverdites and also the lacquer-like surfaces.

A series of valverdites may be easily selected which shows progressive stages of corrosion, from glossy-black specimens that appear almost wholly untouched by any corrosive agent, to dull-black specimens deeply invaded by pits and linear etchings. The greater number, however, are merely roughened on the surface, with very few markings large enough to be discerned easily without a magnifying glass. U-shaped and bow-shaped furrows are very plentiful, but long, deep furrows of the kind that appear on many moldavites and billitonites are entirely missing, as they are also on australites. One specimen, which shows the highest gloss of any specimen in the collection, has what appears to be a thin secondary fusion overlying its surface, tho the evidence is not conclusive. Under the

microscope, one spray of trichites may be seen on its surface which looks like a bunch of white hairs caught beneath a coat of black paint, with only the tip ends exposed. A larger white crystal, still microscopic, resembles a match stick trapped by a finger of black tar across its middle. There has been only one discovery, to the best of my knowledge, of a specimen of natural glass which has been described as having a clearly definable secondary fusion on its surface.[11] This specimen, discovered in southern Sweden, is said to have a crust which in thin section is distinguishable from the compact interior glass. I have been unable to confirm the presence of a secondary surface fusion on the valverdites by examining a specimen in thin section. This fact may, or may not, be significant. Wahl, in his description of the Swedish specimen, comments on the difficulty that was encountered in lighting the crust in a manner to make it clearly visible. The glossy lacquer-like surface which still appears on many valverdites is plainly what remains of the original surface. There is no evidence at all of desert polish, or of any natural or artificial agent other than heat, which could put a gloss on the surface of a rough obsidian pebble. All the evidence indicates a gradual deterioration of the surface, which is first dulled as if it had been treated with hydrofluoric acid. In the next stage, the characteristic minute, overlapping pits on the original surface are corroded away; then bow-shaped furrows and numerous parallel corrosion lines begin to appear on some specimens, and in the final stage the effects of the corrosion are such as to make the surface unsuited to a polish of any kind. It is impossible to interpret the varying surface features of valverdites as indicating a movement in the other direction; *i.e.*, from a rough obsidian pebble to a glossy symmetrical specimen. Many obsidian or perlite specimens from Arizona exhibit a high degree of desert polish, but very few of them have even a semblance of symmetry. None of the polished specimens has the minutely pitted surfaces that characterize valverdites; on the contrary, they are very smooth; they look polished, not lacquered. The progress of corrosion is shown clearly on one valverdite, which exhibits a considerable area of glossiness on a surface that is otherwise dull and featureless. It has the appearance of a specimen that has been partially immersed in hydrofluoric acid. Obviously, the original surface has been corroded away where the glossiness is missing. Spalled and broken surfaces of valverdites never show any tendency to develop markings that resemble the characteristic surface markings of the glossier specimens; on the other hand, these surfaces show the same stages of deterioration as the normal surfaces. All surfaces which have resulted from fractures, with one exception, are bounded by edges that show virtually no evidence of abrasion or rounding by any agency; they have been little affected by any factor other than a mild degree of corrosion since they were broken. One broken specimen is, however, well rounded along all the edges of its fractured surface. This appearance might be explained by assuming that the specimen was broken before, or during, its flight thru the atmosphere.

About half of the specimens are opaque. The rest are translucent, and several are sufficiently transparent to permit indistinct discernment of typewritten letters thru them. They are smoky-amethyst in color. A considerable number of the translucent specimens are crossed by agate-like bands of darker material. These bands, as well as the parallel etchings on some specimens that have undergone corrosion, show an internal structure that could not have resulted from the same process that shaped the valverdites. It is obvious that the glass was formed before the shaping process occurred. This same feature appears in the specimen found in Sweden, which also is banded like rhyolite.[12]

I believe that the features exhibited by valverdites indicate that they may have been subjected to a secondary surface fusion which can be readily explained only by assuming that they have undergone the rigors of a violent flight thru the atmosphere. To eliminate them from consideration among glasses of possibly extraterrestrial origin, solely because they resemble the igneous glass exuded by volcanoes, is no more defensible in logic than to eliminate a stone from consideration as a possible meteorite for no other reason than that it resembles some terrestrial sedimentary formation. This procedure is *a priori* reasoning.

All the evidence pertaining to valverdites, including the circumstances under which they are found, seems to me to suggest that they may have arrived on the Earth at a relatively recent date as compared with the bediasites of Grimes County, Texas, and other known tektites; certainly, the proof is not final.

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The Valverdites: A Weathered Obsidian Form Superficially Resembling Certain Tektites*

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ABSTRACT

This paper is devoted to a critical study of the natural glasses recently found in Val Verde County, Texas. On the basis of the behavior of these so-called *valverdites* under the blowpipe flame; of their low densities and indices of refraction; of the crystallites and megascopic crystals contained in them; and of their other peculiarities, the conclusion is reached that they are not tektites, but are weathered pebbles of obsidian.

Introduction.—In a paper entitled "Tektites in the United States," written by Frank C. Cross and read at the 10th Meeting of the Meteoritical Society at San Diego, California, in June, 1947, attention was called to the discovery, by Orville Lee, near the town of Del Rio, in Val Verde County, Texas, of several hundred remarkably symmetrical specimens of natural glass. Altho these *valverdites*, as Cross called them, differed from all known tektites in that they contained not only crystallites but also megascopic crystals, nevertheless, he regarded them as tektites. In July, 1947, the Editor of the CONTRIBUTIONS OF THE METEOR-

*Read by title at the 11th Meeting of the Society, Albuquerque, New Mexico, 1948 Sept. 7-8.

ITICAL SOCIETY, Dr. Frederick C. Leonard, then serving as Visiting Professor of Astronomy in the Department of Mathematics and Astronomy of the University of New Mexico, asked me, as a member of the Publications Committee of the Society, critically to appraise Mr. Cross's manuscript. I agreed to do so only if an opportunity were given me to carry out certain standard tests on valverdite specimens. Initially, a futile attempt was made to secure such specimens thru Mr. Lee. After a couple of months' delay, a suite of 27 valverdites was obtained from Mr. Cross, who had kindly volunteered to send specimens for critical examination. Shortly thereafter, another suite of 16 valverdites was received from Mr. Lee. The conclusions drawn hereinafter are based upon a study of the 43 valverdites thus made available by Messrs. Cross and Lee. Before proceeding to a discussion of the tests carried out on these specimens, the results obtained, and the inferences drawn, certain preliminary remarks are necessitated by the point of view from which Mr. Cross's manuscript—of which I have now read 3 different versions—is written.

To begin with, it should be noted that a scientific *natural classification* (*e.g.*, in mineralogy, or biology, or meteoritics) is not based upon merely superficial resemblances. To classify whales as fish simply because they swim in the sea is typical of the non-scientific mind, which sees trivially obvious similarities, but overlooks really important basic differences. In the classification of the silica glasses, this important principle has not been overlooked, and, as a result, the glasses grouped together as tektites possess in common certain properties of fundamental significance: *e.g.*, characteristic behavior under the blowpipe flame; densities and indices of refraction in certain ranges; and characteristic freedom from crystallites. The totality of these and other characteristic properties gives what may be described as the currently accepted definition of tektite.

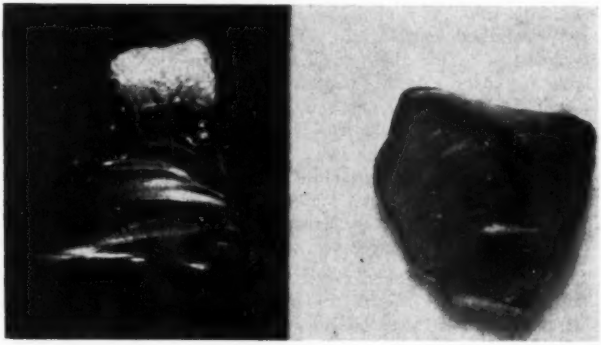
In the original version of Cross's paper, attention was given to only the last of the properties specifically mentioned in the preceding paragraph; and the fact that the valverdites contain not only crystallites but also megascopic crystals was regarded as less significant than the superficial resemblance in form between the valverdites and one type of australite. In the third version of Cross's paper, published in the present instalment of *C. M. S.* (*ante*), reference is made to results on the non-characteristic behavior of the valverdites under the blowpipe flame, and on the non-characteristic values of their indices of refraction and their densities, results which I communicated to him in a letter under date of 1947 December 28. Instead of destroying Cross's belief that the valverdites are tektites, the cumulative effect of the negative evidence obtained by my tests on these glasses has been, however, to lead him to charge me with "*a priori* reasoning" in refusing to accept them as tektites! Consideration of this anomalous situation leads to the conclusion that Cross, by rejecting the definition of tektite heretofore adopted, and by substituting his own definition of tektite, as "any glass of extraterrestrial origin," believes that he has now shifted onto his critic's shoulders the task of disproving that the valverdites are of extraterrestrial origin. A more illogical procedure could scarcely be imagined, and I have no intention of attempting any such disproof. My sole purpose in what follows will be to show that in several important particulars the valverdites fail to satisfy the currently accepted definition of tektite. If he so wishes, Cross may re-define tektite as "*any* glass of extraterrestrial origin"; but he must then assume the responsibility of proving not only that his definition is a better definition than the old one but also that the valverdites actually satisfy the new definition.

§1. *Results of Blowpipe Tests on the Valverdites.*—For at least three-quar-

ters of a century, it has been known that tektites and ordinary obsidian behave quite differently under the blowpipe flame, the former melting with difficulty to a clear glass, the latter proving much less refractory and giving rise to a frothy opaque melt. It would appear that not all of those interested in the silica glasses are familiar with this venerable test, for otherwise, in view of its extreme simplicity, one would expect to see it used in every case before a new find of natural glass is pronounced to be, or not to be, a tektite. We shall therefore give in some detail the results obtained by subjecting valverdites and control specimens to the blowpipe flame.

In carrying out a blowpipe test on the valverdites, it was decided to use as controls, fragments of the ordinary obsidian occurring on the high mesa east of Albuquerque, and bediasites, the Texas tektites found some distance north and east of the Val Verde area. A typical valverdite chip is shown in Fig. 1*a*, after exposure to the blowpipe flame. Initially, this chip appeared thruout to be quite as homogeneous and transparent as a similar, thin bediasite chip, differing from the latter, to the naked eye, only in color (the valverdites in this regard resembling smoky topaz or quartz in hue, the bediasites being of a warm, greenish-amber color); and, under a low-power microscope, only in exhibiting possibly fewer very tiny spherical cavities than were visible in the bediasite chip. Before heating, neither chip contained other than very tiny spherical cavities.

On subjecting the valverdite chip to the blowpipe flame, it was found to melt quite as easily as the obsidian control, and, like the latter, to evolve, in liquifying, a relatively large amount of gas. As a result, the valverdite melt was from the beginning quite frothy in character, notably exceeding in volume the solid glass from which it was derived. When allowed to congeal, the froth hardened into the white opaque mass shown in Fig. 1*a*. Examined under a low-power microscope, this congealed froth was found to be cellular in structure, consisting primarily of numerous spherical, quasi-spherical, and irregular shells of glass, no doubt imprisoning gas bubbles somewhere near atmospheric pressure, for the glass shells are in many cases so extremely thin that it seems impossible that they could resist disrupting forces of any appreciable magnitude. Most of the external surface of the white froth is thickly pimpled over with smooth spherical caps and hemispheres of glass, resembling, more nearly than anything else, the familiar botryoidal structure, but on a most exiguous scale. Occasionally, the irregular, jagged walls of the basal portions of shattered glass shells, and, rarely, filamentary arches of glass are discernible, rising above the general level of the surrounding surface. The entire frothy mass is separated from the unmelted portion of the valverdite by a roughly plane surface, *S*, approximately perpendicular to the plane, *P*, of the photograph. The line of intersection of *S* and *P* shows up sharply in Fig. 1*a*; indeed, too sharply, for an instantaneous transition from the congealed froth to the unmelted valverdite is suggested, and this is by no means the case, since, below *S*, *i.e.*, in the solid glass, the heat of the blowpipe flame has developed a considerable number of large-to-excessively-minute, but always exactly spherical, gas bubbles, largest and most numerous near *S*, and disappearing at a distance below *S* roughly equal to the depth of the white froth. Some of the largest of these spherical cavities can be seen in the photograph. The description just given, and the photograph in Fig. 1*a*, make clear that very marked changes are produced in a fragment of valverdite merely by heating it in the blowpipe flame. Precisely such changes were observed also in the obsidian control. With very minor differences, they were observed to occur also in fragments of obsidian from several other localities. On the contrary, almost no



(*a*) (*b*)

FIGURE 1

A valverdite chip, after exposure to the blowpipe flame, is shown in (*a*), and a bediasite chip, after exposure to the same flame, in (*b*). In both photomicrographs, the magnification is × 8.

change is produced in a chip from a bediasite, no matter how long and how intensely it is heated in the blowpipe flame. As is clearly shown in Fig. 1*b*, in which the heated portion of the bediasite is at the top, the only change discernible to the naked eye, even after prolonged exposure to the flame, is a rounding-off and smoothing-out of such sharp edges and corners as still show in the unheated, lower portions of the chip in Fig. 1*b*. Even under the low-power microscope, no additional change is certainly discernible, altho I have gained the impression that a very slight increase occurs in the number and/or the size of the tiny spherical cavities naturally present in bediasites. With minor variations, the same indifference to the blowpipe flame has been shown by all other genuine tektites tested by me; these include australites, rizalites, billitonites, and what is very probably a moldavite.

§2. *Results of Density Determinations on the Valverdites.*—Density determinations on the valverdites were made by use of a standard Joly balance. Weights were recorded both for complete stones and for large fragments selected from the debris of valverdites being crushed up in connection with the index of refraction measures discussed in the next section. Before weighing in water, the immersed specimens were freed of air films and bubbles by gentle scrubbing with a camel's-hair brush. The mean of the density determinations made on 10 specimens was $d = 2.30$, to the nearest hundredth. This is even less than the density of the control obsidian, for which $d = 2.33$, and is much less than the density of the average tektite. Except for the moldavites, the average densities of the various recognized tektites fall in the range 2.37 to 2.40; the moldavites average about 2.34.

§3. *Results of Index of Refraction Determinations on the Valverdites.* — Determinations of the index of refraction of the valverdites were made by use of the familiar immersion method. Specimens were crushed up, and the finely powdered valverdite was suspended on glass slides in droplets chosen from a series of index oils with monotonically increasing indices of refraction. By ob-

serving a specific flake of valverdite under the petrographic microscope, and by noting the direction of motion of the Becke line as the objective lens of the microscope was raised and lowered, it was possible to determine whether the index of refraction of the glass was less or greater than that of the index oil in which it was immersed. No temperature corrections were applied in these refractive-index determinations, since we desired a final result accurate to only the nearest hundredth, and all the work was carried out at temperatures differing but little from that at which the index oils had been calibrated. The mean of index of refraction determinations on 10 specimens was $n = 1.48$, to the nearest hundredth. This is even less than the refractive index of the control obsidian, for which $n = 1.49$. Except for the moldavites, for which n averages about 1.49, the average indices for genuine tektites fall in the range 1.50 to 1.52.

§4. *Further Critical Remarks on the Valverdites.*—Altho, in my opinion, the results obtained in the last 3 sections, coupled with the presence in the valverdites of crystallites and even megascopic crystals, preclude the possibility that this recently discovered natural glass is a variety of tektite, nevertheless, for reasons hinted at in the introduction, it seems desirable to make certain additional critical remarks on the valverdites.

In reply to a question concerning the distribution of large and small valverdites in the elliptical area of find, asked in my letter to him under date of 1947 July 30, Mr. Lee made the following statement, under date of August 3: "There was a tendency for the larger ones to be found in the northwest area; also, there seemed to be more of all sizes, and [they] thinned out to smaller and fewer in the southeast." Mr. Cross interprets this reply as signifying that the distribution of the valverdites with respect to size in the elliptical area of find "parallels the distribution of meteoritic showers." Mr. Lee's somewhat ambiguous statement is, however, susceptible of a different interpretation, *viz.*, that valverdites of *all* sizes were to be found in all parts of the elliptical area, but that the proportion of large to small specimens, as well as the absolute number of specimens, fell off as one proceeded from northwest to southeast. If this is the sort of distribution actually observed by Mr. Lee, it certainly does not conform to that observed in a meteoritic shower. In such showers, *e.g.*, the larger individuals are confined to the end of the ellipse pointing in the direction of motion of the falling meteorites.

As has been pointed out by A. Lacroix, the surfaces of genuine tektites are always more or less carved out with "deep and characteristic sculptures." Such characteristic sculpturing was notably absent from the valverdite specimens sent me for examination; in fact, the surface markings observed on these specimens almost invariably resembled much more closely those visible on weathered pebbles of obsidian than those occurring on typical tektites; furthermore, some of these valverdites showed a banded or lamellar internal structure, closely resembling that found in certain New Mexican obsidian pebbles, but quite distinct from the true flow structure observed in tektites. Cross notes that a similar banded structure appears in the natural glass (schonite) from Hof Kälnä in Sweden. This, however, can be regarded less as evidence supporting the conjecture that the valverdites are tektites than as testimony unfavorable to the belief that schonite itself is tektitic. Probably the strongest evidence in support of the latter supposition is the so-called secondary fusion crust observed on the Hof Kälnä specimen by both Eichstädt and Wahl. Cross's statement in the version of his paper read at San Diego, that one of his valverdites had "an extremely thin secondary fusion crust overlying its surface" was therefore deemed

significant, and the reported crust was searched for most carefully on the valverdite in question. I was, however, unable to find such a feature, not only on this particular valverdite but also on any one of the other 42 specimens sent me for examination; and, in the last version of his paper (*ante*), Cross notes that he has "been unable to confirm the presence of a secondary surface fusion on the valverdites by examining a specimen in thin section." Hence, there is no evidence that the valverdites possess the feature that is the strongest argument so far advanced for ascribing a tektitic character to the problematical schonite; similarly, Cross presents no evidence showing that the valverdites actually include the gases CO_2, CO, and H_2 found not only in tektites but also in the obsidian-like, crystallite-containing *americanites*, to which he thinks it likely the valverdites are "closely related." Moreover, those familiar with the inability of competent archeologists and field meteoriticists to decide whether the patinations observed on artifacts and meteorites have their origin in the action of wind-blown dust and sand, or are produced by other agencies, will not be inclined to take too seriously Cross's confident interpretation of the varying degrees of glossiness exhibited by the surfaces of valverdites. In Cross's opinion, "the glossy lacquer-like surface which still appears on many valverdites is plainly what remains of the original surface," this surface having resulted from "a secondary surface fusion" undergone by the valverdite during "violent flight thru the atmosphere." Other interpretations of "the varying surface features" of the valverdites are, however, certainly possible: on the one hand, the gloss observed over all, or part, of the valverdite surfaces may be simply desert polish developed on what were initially rough but reasonably symmetrical obsidian pebbles, the extent of the

FIGURE 2

Two symmetrical obsidian pebbles found near the New Mexico Proving Ground are shown in the upper row, and the halves of 2 valverdites sectioned for microscopic study, in the lower row. The specimens are shown as of their natural size.

polished area depending upon the degree of exposure experienced by the individual pebbles; on the other hand, certain obsidian nodules included in perlite have surprisingly glossy, lacquer-like surfaces. It is quite conceivable that reasonably symmetrical nodules of this sort released by disintegration of the perlite matrix and subjected to the same corrosive process which Cross envisages as having operated on the valverdites would exhibit the same stages of progressive surface deterioration which he believes he has identified in the Texas glass specimens.

Finally, the symmetry of the valverdites has been so strongly stressed by Cross that the following remarks seem desirable. On the one hand, it is possible that an eye for symmetry influenced Mr. Lee in perceiving the particularly symmetrical valverdites he actually recovered or chose to send to Mr. Cross and to me; on the other hand, even if no such selective influence is found to have been in operation, the symmetry of the valverdites does not set them off too sharply from weathered obsidian pebbles, for, among the latter, occur specimens quite as symmetrical as any valverdites. This fact is brought out by Fig. 2, which shows 2 pebbles of obsidian found by me near the New Mexico Proving Ground: one in the upper row, and the halves of 2 typical valverdites in the lower row of the figure. Incidentally, one of the obsidian pebbles shows surface features more suggestive of the characteristic tektitic sculpturing than either of these valverdites.

In my opinion, the results of the various tests and observations described in this paper render inescapable the conclusion that the valverdites are not tektites, but are weathered obsidian pebbles.

The Oxide Crust of the Willamette, Oregon, Meteorite

Russell A. Morley
399 North 18th Street, Salem, Oregon

ABSTRACT

More than 8,500 gm. (15¼ lb.) of the oxidized crust of the Willamette, Clackamas Co., Oregon, siderite (C.N. = 1226,454; cl. = Om) have been recovered from the recently excavated crater in which that meteorite lay. This material, of hardness 6 and average specific gravity about 3.8, is described, and the disposition that has been made of it is recorded.

Early in May, 1948, I began an excavation of the Willamette, Oregon, meteorite crater. The crater was at that time 17 feet in length, 10 feet in breadth, and 2 feet in depth. It is located on what is now the Lloyd W. Smith farm, on the Grapevine road, a short distance north of the town of Willamette. The crater to date has yielded over 8,500 gm. of oxide, or a little over 15¼ lb. The largest amount of oxide was recovered at a depth of 3 feet. The material is a complex of both nickel and iron oxides, arranged in a laminated structure. The outer surface is coated with limonite, by hydration. The oxide has a hardness of 6. The average specific gravity of 4 samples selected at random is 3.835:

Specimen	1:	3.814
"	2:	3.497
"	3:	3.929
"	4:	4.103

The ground, for several feet around, is rich in nickel, giving a heavy precipitate with dimethylglyoxime reagent. This fact in itself should give some idea of the

long period of time during which the meteorite must have lain exposed to weathering, before its discovery in 1902.

The oxide specimens now in my collection may be described as follows: the heaviest weighs 238.4 gm.; its length is 11 cm., breadth 7 cm., and thickness 1.5 cm.; the thickest specimen is 2.1 cm. thick, but was, as nearly as I can estimate, at least 0.3 cm. thicker originally; the largest specimen has dimensions of $12 \times 13 \times 1$ cm.

A careful analysis of the oxide, as well as of the surrounding soil, revealed no trace of sulfides or sulfates, the presence of which might have helped to explain the deep cavities in the base of the meteorite.

The material has been disposed of thus: 6 specimens were presented to Dr. J. Hugh Pruett of the University of Oregon, for his private collection; 6 were sent as exchange specimens to Dr. H. H. Nininger, Director of the American Meteorite Museum, near Winslow, Arizona, where they are now on display in the Nininger collection; an equal number were sent, for exchange, to Dr. W. R. B. Oliver, Director of the Canterbury Museum, Christchurch, New Zealand; and the remainder of the material went to Ward's Natural Science Establishment of Rochester, New York.

An Announcement concerning Future Explorations at the Canyon Diablo, Arizona, Meteorite Crater

In the summer of 1939, the First Ohio State University Meteorite Expedition, and, in the summer of 1941, the second such expedition, carried out preliminary meteorite surveys in the area of the Barringer (Canyon Diablo, Arizona) Meteorite Crater, employing meteorite detectors developed at the Ohio State University. During the second of these surveys, use was made also of special detecting equipment, designed and built by the late Harry A. Fore of Glendale, California, at the request of Dr. Frederick C. Leonard of the University of California, Los Angeles, who participated in the field work. The advent of the war and the transfer of the Director of the Ohio State University Expeditions, namely the undersigned, to O.S.R.D. and O.A.D. appointments, interrupted plans for the continuance of systematic work in the Canyon Diablo region; and, since the termination of the Ohio State University surveys, only desultory and superficial work, directed chiefly toward the exploitation of the meteoritic deposits at and around the Barringer Crater, for commercial purposes, has been under way.

On January 15, 1948, an agreement between the Bar-T-Bar Ranch and the Institute of Meteoritics of the University of New Mexico, and, on July 3, 1948, an agreement between the Tremaine Alfalfa Ranch and Milling Company of Arizona and the Institute were signed, whereby the Institute acquired exclusive rights to conduct meteorite surveys and to recover meteoritic materials on all lands owned or leased by the Bar-T-Bar Ranch and the other Tremaine interests at and around the Barringer Meteorite Crater in Coconino County, Arizona. On October 11, 1948, a similar agreement was signed between the Institute and the Standard Iron Company of Philadelphia, the owner of the patented Mars, Venus, Saturn, and Jupiter placer-mining claims, within which the Barringer Crater is situated.

Since the integrated area of the regions thus opened to systematic exploration, by the arrangements just detailed, comprizes approximately 50 square miles,

at or near the world's largest recognized meteorite crater, the magnitude and the importance of the task on which the Institute of Meteoritics will in the near future embark can be easily appreciated.

LINCOLN LA PAZ, *Director*,
Institute of Meteoritics, University of New Mexico, Albuquerque,
1948 October 30

President of the Society: ARTHUR S. KING, 925 Topeka Street, Pasadena 6, California
Secretary of the Society: OSCAR E. MONNIG, 1010 Morningside Drive, Fort Worth 3, Texas

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VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

AAVSO Annual Meeting, October, 1948: Under most auspicious skies and truly salubrious weather conditions, the AAVSO held its 37th Annual Fall Meeting at the Harvard Observatory on October 15 and 16. The Council met on Friday afternoon to transact important business matters, and in the evening a joint meeting was held with the Bond Astronomical Club and the Amateur Telescope Makers of Boston, at which Professor Charles H. Smiley gave an illustrated talk on his trip to Siam to observe the annular eclipse of last May.

An exceptionally large audience was in attendance and they listened attentively to a travelogue that was most abundantly illustrated by Kodachrome slides of Dr. Smiley's own handiwork. Following the lecture a well-arranged collation was served, and later there was an opportunity for members and guests of all three groups to observe the heavens through telescopes, including a peep by some of the AAVSO observers at SS Cygni, which was reported to be still at a minimum!

On Saturday morning more than 50 AAVSO members gathered in the Observatory Library to participate in the business session. Acting-President David W. Rosebrugh, in the absence of President Marjorie Williams, opened the meeting promptly at 10 o'clock. Announcement was made of the election by the Council of 15 new members bringing the total for the year to 35. The names of the new members are as follows:

James G. Baker, 109 Hillcrest Drive, Orinda, California
Raoul Bajocchi, 3 Haret Zogheb Street, Cairo, Egypt
Frederick W. Betzner, 628 Ohio Avenue, Glassport, Pennsylvania
Leo M. Carroll, 2013 New Hampshire Avenue, Washington 8, D. C.
Chester Cook, 16 Belfry Terrace, Lexington, Massachusetts
Alika K. Herring, 2228 Winton Street, Middletown, Ohio
Vahram S. Kardashian, 1 Gameh Charkass, Cairo, Egypt
Eugene R. Kosche, 340 Wahconah Street, Pittsfield, Massachusetts
Rolland R. LaPelle, 54 Fernleaf Avenue, Longmeadow 6, Massachusetts
J. W. MacQueen, 3148 Pine Ridge Road, Birmingham 9, Alabama
T. P. Maher, Vendome Hotel, Arlington, Oregon

Russell K. McNiel, 3417 Palmer Street, Chicago 47, Illinois
Moffett M. Potter, P. O. Box 384, Waynesboro, Virginia
Leon E. Salanave, Sacramento College Observatory, Sacramento 14, California
Clyde L. Stensrud, Rte. 1, Box 57, Atchison, Kansas

The following members were elected to the Council for a two-year term:

Ferdinand Hartmann, St. Albans, New York
Margaret W. Mayall, Cambridge, Massachusetts
Paul H. Nadeau, Quebec, Canada
Martha E. Stahr, Ithaca, New York

The Council later elected the following officers:

David W. Rosebrugh, President
Neal J. Heines, First Vice-President
Martha E. Stahr, Second Vice-President
Clinton B. Ford, Secretary
Percy W. Witherell, Treasurer
Leon Campbell, Recorder

Mr. Herbert M. Harris of South Portland, Maine, had declined to serve again as Secretary, after acting for three years in that capacity.

The Ninth Merit Award of the Association was presented to Mr. Cyrus F. Fernald, of Wilton, Maine, "one who has made outstanding observational contributions to the study of variable stars, and who has done much to maintain the continuity of the light curves, especially during the recent war years."

The Recorder's annual report indicated continual activity in the work of the Association, not only in variable star observing, but in occultation and solar observations as well.

The total number of variable star observations contributed to headquarters was 54,370 by 154 observers, 4,000 more than in 1946-47, and 10,000 more than in the year 1945-46. Mr. Fernald again headed the list in the number of estimates contributed, with a total of 7,504, and R. P. de Kock, of Capetown, South Africa, ranked second with 4,729 estimates. Forty-nine observers in 17 foreign countries contributed 25,042 observations, with 9,421 by 11 observers in Greece alone.

The McAteer Library of the Association has been increased by 57 volumes and 200 pamphlets. A move has been started to increase by donation and subscription the number of books and pamphlets in the solar section, so that the most up-to-date material may be made available, especially to members of the Solar Division.

The report of the Solar Division indicated a steady progress, with contributions from 184 observers distributed through 29 states and 11 foreign countries. A total of 10,374 solar observations was contributed for the year, bringing the grand total to date to 39,758. Programs being followed are sunspot counts, granulations, colors in spots, unusual spot configurations, foreshortening of sunspot groups, bird migrations, delineation and area of spots. An attractive Solar Division placard has been designed by the chairman, Mr. Heines.

Dr. Farnsworth reported for the Occultation Committee that for the year 1947 there were 88 occultations observed by 18 different people, 29 of which were made by Emil A. Sill of Mamaroneck, New York, and 22 by the National Capital Observers in Washington, D. C. Messrs. Millard, Mary, and Green contributed 7 each. During the year 1948, forty-nine observations were received, with evidence of fresh activity in the Northwest, with reports from Messrs.

Ribbe and Maher. Included were observations of three occultations of Mars on January 24, February 24, and September 6.

As opportunity offers, it is planned to issue new library and slide catalogues, as well as a new membership list. The publication of the 1949 Julian Day Calendar was assured through the generosity of a new, but still anonymous, patron.

Following the business sessions, papers dealing with the work of the members were presented. These included:

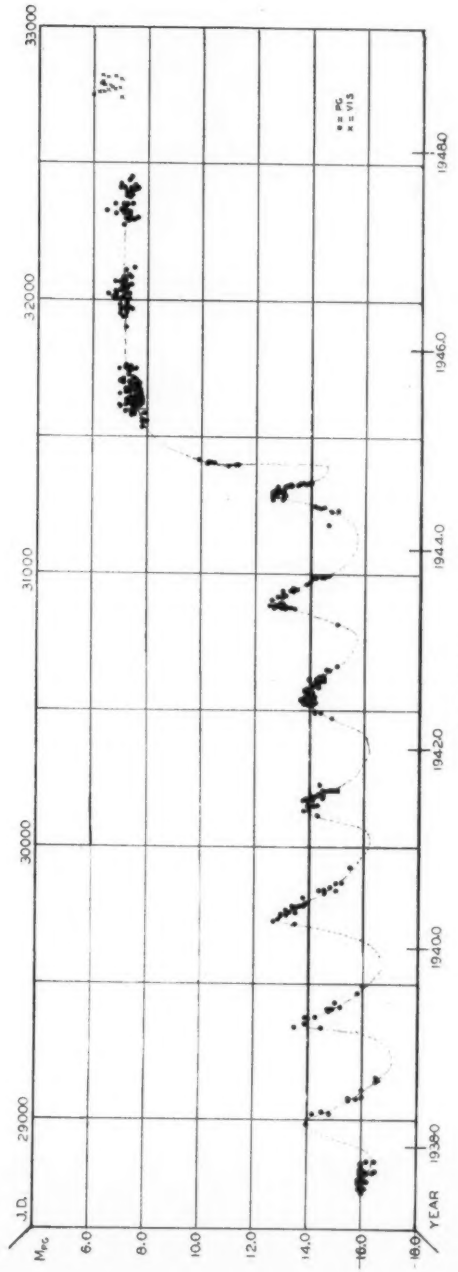
"A New Variable Star," Dorrit Hoffleit
"Cepheid Variables," Harlow Shapley
"Bright Maxima of RR Telescopii," R. P. de Kock
"Light Curve of RR Telescopii," Margaret W. Mayall
"Solar Granulations," James C. Bartlett, Jr.
"Fun With a Photometer," J. J. Ruiz
"A Type of Wedge Photometer," Stanley Brower
"Current Light Curves of Variables," Leon Campbell
"Greenwich Observatory, Old and New," C. A. Federer, Jr.
"Observations of Planets," John Streeter
"Estimating Magnitudes of Saturn's Satellites," R. R. LaPelle

In Mr. de Kock's paper, attention was called to the current brighter than usual maximum of RR Telescopii. Mrs. Mayall, who had recently examined the star on Harvard plates taken over the past fifty years, gave much additional information. Where no previous maximum had been noted to rise above photographic magnitude 12, the present maximum rose to magnitude 7. The present maximum began its well-defined increase in light late in 1944, and in 1945 had attained the 7th magnitude and there it remained through the observing season of 1947. The visual magnitude, according to the observers in South Africa, Messrs. de Kock and Kirchhoff, had attained magnitude 6.0 during the present year. The plot of the photographic observations as determined by Mrs. Mayall is shown in Figure 1 (next page) as dots, and the recent visual estimates as crosses.

Dr. Hoffleit's paper dealt with a new variable star, BD 20°2337 ($9^h\,27^m.7$, 20° 18′, 1900). Dr. Vyssotsky of the McCormick Observatory had reported suspected bright lines in the spectrum of the star, which were later confirmed by Dr. Joy of Mount Wilson Observatory, with the suspicion that the star might be an RV Tauri-type variable. An examination of Harvard plates by Dr. Hoffleit showed the star to be a semi-regular variable, but that it does not present the alternate shallow and deep minima which are typical of RV Tauri stars. The amplitude of variation is variable, at times as much as two and a half magnitudes (photographic), and at other times less than one magnitude. The variation can be represented by a period of 103.2 days. Visually, the star should vary from about magnitudes 10 to 13.

Dr. Shapley referred to the use of standard light curves for Cepheids in the following terms.

One of the most remarkable of the many remarkable phenomena associated with the pulsating Cepheid variable stars is the similarity of the light curves of variables that differ so widely in size, mean density, mass, and especially in period length. For theoretical studies of Cepheid variation, it is important not only to have very precise curves of individual maxima of individual stars, which now can be obtained with photoelectric photometers, but also to obtain precise mean curves for the average or typical Cepheid at various period lengths. On



RR TELESCOPII 195656

FIGURE 1

the basis of an extended study of light curves in the Magellanic Clouds, it is now possible to provide these average light curves, and a detailed presentation will appear soon in a Harvard Observatory reprint.

Supplementing the typical light curves at different period lengths from two days to twenty days, a single standard Cepheid light curve, based on extensive data for more than sixty variables of the Small Magellanic Cloud, has also been deduced and the normal points tabulated. The possibility of using a single master photographic magnitude sequence in each of the Clouds has permitted an unusual homogeneity in the derivation of this standard light curve which probably at all phases is accurate to two or three thousandths of a magnitude.

The business sessions adjourned at four o'clock, after which tea was served by the ladies of the Observatory.

The evening dinner was held at the Gateway Restaurant, at which some seventy members and guests gathered. Mr. Federer acted as toastmaster, and introduced in turn, Dr. Shapley, Dr. Brouwer, and Mrs. Mayall, who related incidents in connection with the summer meeting of the I.A.U. in Zürich, Switzerland. Later, Dr. Shapley recounted the 1948 Highlights in Astronomy, as listed herewith:

1. International Astronomical Union meeting in Zürich, Switzerland.
2. Discovery of the fifth satellite of Uranus by Kuiper.
3. Dedication of the 200-inch reflector at Palomar.
4. The Norton Meteorite of February 18, 1948.
5. The 100th white dwarf announced by Dr. Luyten of the University of Minnesota.
6. Proposed creation of an International Observatory or Laboratory by the U.N. and UNESCO.
7. Discovery and study of general magnetic fields in certain stars by Dr. H. W. Babcock of the Mount Wilson Observatory.
8. Completion of plans for the Baker-Schmidt 32-inch telescope, to be operated jointly by Armagh, Dunsink, and Harvard on the Harvard Kopje, South Africa.
9. The establishment of microwave astronomy as a principal branch of our science, through the use of radar and similar apparatus.
10. The progress made by Drs. Stebbins and Whitford on increasing redness with distance for faint galaxies.

The occasion closed with a vote of appreciation to all those who had made the meetings so successful, and adjourned until next spring, to meet in some place yet to be chosen.

Observations contributed during September and October: A total of 12,155 observations was contributed—6,034 in September and 6,121 in October—by 88 observers as follows:

	September—1948—October					September—1948—October			
Observer	No. Var.	No. Ests.	No. Var.	No. Ests.	Observer	No. Var.	No. Ests.	No. Var.	No. Ests.
Adamopoulos	...	...	9	9	Bicknell	...	...	12	88
Ahnert	43	329	42	312	Blunck	11	13	48	63
Albrecht	5	5	16	16	Bogard	43	56	54	140
Ancarani	25	43	...	...	Bonelli	2	2	3	3
Bajocchi	11	57	17	29	Boone	...	...	34	38
Ball	6	6	...	...	Buckstaff	18	60	19	57
van den Bergh	8	711	...	...	Bufkin	...	...	3	20

Observer	September—1948—October No. Var.	No. Ests.	No. Var.	No. Ests.	Observer	September—1948—October No. Var.	No. Ests.	No. Var.	No. Ests.
Cain	20	49	27	48	Luft	6	95	7	67
Chandra	...	...	35	39	Miller	31	56	24	32
Chassapis	110	540	143	571	Nadeau	82	94	80	102
Cilley	...	...	38	158	O'Byrne	13	19	...	...
Cragg	129	131	174	179	Oravec	44	160	37	98
Dafter	...	...	7	17	Paletsakis	8	185	9	193
Daley	6	36	5	13	Parker	35	35	21	21
Darling	...	...	7	25	Parks	22	32	25	26
Darnell	2	3	1	3	Pearcy	76	76	95	96
Debono	7	13	...	...	Peltier	190	311	147	221
Dillon	3	5	5	9	Penhallow	35	54	31	61
Edelenyi	...	...	4	8	Pierson	26	48	28	66
Elias	68	295	65	233	Plakidis	...	...	5	23
Estremadoyro, G.	2	2	1	1	Rakosi	...	...	6	37
Estremadoyro, V.	..	...	5	5	Reeves	2	4	2	6
Farkas	...	...	3	6	Renner	111	111	66	80
Fernald	258	669	313	934	Rich	8	12	11	15
Focas	...	...	72	113	Rosebrugh	23	228	17	257
Ford	24	25	8	8	Ruiz	16	24	14	25
Garneau	30	35	...	...	Rusho	9	20	7	16
Gingerich	29	46	8	14	Schoenke	7	10	...	...
Greenley	41	106	44	131	Seagroves	7	7	9	9
Halbach	55	58	6	6	Svolopoulos	21	25	22	27
Hamilton	6	11	4	8	Szabadosi	...	...	4	9
Hardi	...	...	5	19	Tarbell	6	13	...	...
Hare	15	25	...	...	Tifft	37	60	12	12
Hartmann	123	142	144	160	Tsuneoka	...	...	10	10
Herring	1	8	10	15	Upjohn	38	38	25	30
Hiett	9	14	11	18	Venter	...	...	8	17
Holloway	10	11	5	5	Waldmann	...	...	14	25
Howarth	12	12	14	14	Waters	5	15	3	3
Kirchhoff	51	85	42	132	Webb	15	15	28	30
de Kock	110	407	105	423	Welker	13	22	28	45
Koons	33	48	21	24	Wells	3	3	4	4
Lacchini	17	47	41	117	Werntz	...	...	19	47
Lee	24	51	22	29	Yamada	10	21	9	19
Leinbach	3	4	2	3	—				
LeVaux	85	102	23	23	88 totals		6,034		6,121

November 15, 1948.

Comet Notes

By G. VAN BIESBROECK

COMET 1948 *l*. Southern observers have once more been favored with an opportunity to see a bright comet with the naked eye. On November 8 Dr. J. Paraskevopoulos, in charge of the Harvard Station at Bloemfontein (South Africa) gave the rough position:

Right ascension $13^h\ 27^m$; Declination $-21°$

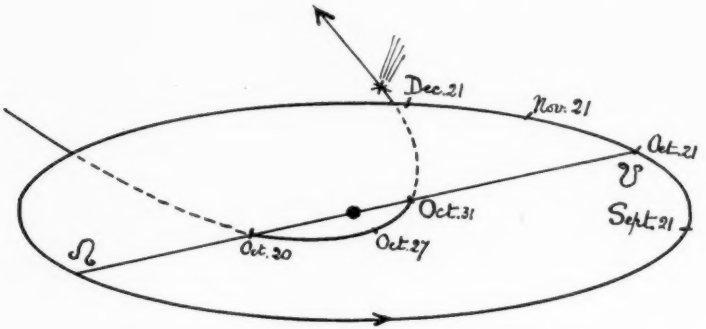
for a comet that had been sighted first on the morning of November 7. The comet was described as having a nucleus of magnitude 2 and a tail 20 degrees long. The same morning observers at Tonanzintla (Mexico) called the head "brighter than Venus, but estimated the length of the tail as 10 degrees.

Such a bright object must have been independently picked up by many ob-

servers and like comet 1947 *n*, which startled southern observers last December, it will probably not receive the name of any particular discoverer.

On the following days many people saw the comet in the southern states but for our latitudes it was too low on the southeastern horizon to be clearly visible before sunrise. It was however carefully watched in southern observatories and in the afternoon of November 11 a preliminary parabolic orbit was already broadcast from the Cape Observatory. The elements, deduced by Hirst from measures on November 8, 9, and 10 were reported as follows:

Perihelion time 1948 Oct.	27.460 U.T.
Node to perihelion	106° 0′
Longitude of node	209 44
Inclination	22 48
Perihelion distance	0.1296 Astr. Units



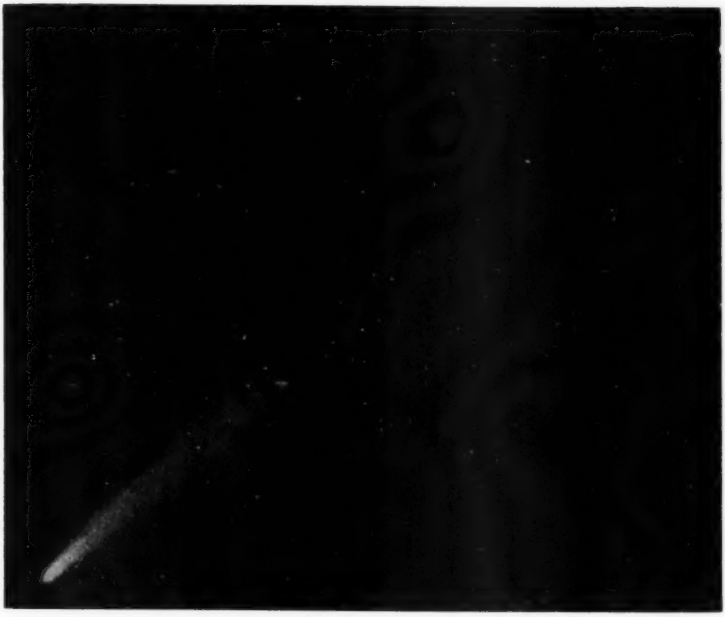
ORBIT OF COMET 1948 *l* RELATIVE TO THAT OF THE EARTH.

The diagram herewith shows the relative positions of the sun, the earth, and the comet near perihelion time. The earth's orbit is represented by the closed ellipse while the open curve corresponds to the path of the comet. Coming from the south and behind the sun it had crossed the nodal point on October 20. On the date of perihelion, October 27, it was located about 7 degrees east of the sun and about two magnitudes brighter than on the date of first observation, November 7. Surprisingly nobody noticed its presence earlier. Its tail must have been well visible in the evening after sunset at the end of last month. On November 1 the comet was almost projected on the sun but after that date it gradually emerged on the west side of the sun, south of the ecliptic.

The rapid westerly motion during November will make the comet visible in the dark of the night but its low declination will be unfavorable for stations in these latitudes. The extrapolated ephemeris gives the following positions:

	R.A.	Dec.
1948 Nov. 30	$10^h\ 20^m$	—34°.1
Dec. 4	9 45	—34.5

which should make it easy to pick up the object although by that time it will have lost its great brilliancy and remain at low altitude.



PHOTOGRAPH OF COMET 1948 *l*, TAKEN AT McDONALD OBSERVATORY BY MR. BRAUN ON NOVEMBER 14, 1948. EXPOSURE, 10 MINUTES.

COMET WIRTANEN (1948 *k*) which has not yet been mentioned in these notes is a faint object recorded on plates taken by C. A. Wirtanen at the Lick Observatory. The discovery information was as follows:

1948 Oct. 7.19694 U.T.
Position: R.A. $21^h\ 29^m8$ Dec. $-2°\ 58'$
Daily Motion 42^s west, $10'\ 42''$ south
Magnitude 14. Object diffuse with central condensation.

These data were however not broadcast until October 13 at which time the moon interfered with the observation. From the available material obtained at the Lick Observatory rough preliminary orbits were computed by A. D. Maxwell and L. E. Cunningham but there remains a great deal of uncertainty about the elements, except that the comet has long since passed its perihelion and is very far from the sun. By the beginning of December the magnitude will have dropped to 15.5.

Little is to be added to the notes of last month concerning the previously discovered faint comets which remain under observation. All the periodic comets expected this year have been recovered except the unfavorably situated PERIODIC COMET NEUJMIN 2, (1916 II), whose position is quite uncertain. Three returns have remainer unobserved since it was last seen in 1927.

Williams Bay, Wisconsin, November 13, 1948.

General Notes

Mr. William Gaertner, president of the Gaertner Scientific Corporation of Chicago, died on December 3. Mr. Gaertner has been well and favorably known by astronomers and other scientists for many years because of his precise workmanship in the making of optical and measuring instruments.

The Rittenhouse Astronomical Society, of Philadelphia held its monthly meeting on October 8, 1948, in the Randal Morgan Physics Laboratory, University of Pennsylvania. The speaker was Dr. I. M. Levitt, Franklin Institute, on the topic, "Some Unsolved Mysteries of Science." On November 12, 1948, the Society met in the same place and listened to a talk by Mr. Charles A. Federer, Jr., editor, *Sky and Telescope*, on "Astronomy in Europe."

American Astronomical Society,—By invitation of Dr. Dirk Brouwer, the eightieth meeting of the Society will be held at the Yale University Observatory, New Haven, Connecticut, December 28-31, 1948.

Two special sessions are being planned on Thursday afternoon, December 30. A small symposium of three invited papers on the subject of microwave astronomy is being arranged by Professor Charles R. Burrows, Director of the School of Electrical Engineering at Cornell University, starting at 2:00 p.m. This will be followed by a Teachers' Conference at 3:30 p.m.

After the Society dinner, which is scheduled for 6:30 p.m. on Thursday, there will be a series of talks about the recent I.A.U. meeting in Zürich. The discussion will be led by Dr. Harlow Shapley, followed by short comments by Drs. Dirk Brouwer, Gerald M. Clemence, and Otto Struve.

Eighth Annual Science Talent Search

The Annual Science Talent Search is now being carried out. It pertains to those who are seniors in secondary schools. The search is conducted under the auspices of the Science Clubs of America and is administered by Science Service, Washington, D. C. The awards include 40 all-expenses-paid trips to Washington for the Science Talent Institute and $11,000 in Westinghouse Science Scholarships. Scholarship opportunities will come also to 260 persons who are given honorable mention each year. Complete information may be obtained by addressing a request to Science Clubs of America, 1719 N Street Northwest, Washington 6, D. C.

Editor's Note.—Through an oversight we neglected to state that the paper entitled "Stonyhurst College Observatory," page 487 of the preceding issue, was originally printed in the British magazine *Nature*. We hereby wish to correct this error.